Investigating the Value of Formal Alliances and Competitor Interdependency in the Development of Consumer Technology Standards

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Abstract

The thesis explored the phenomena of co-opetition and the interdependency between competitors, with the establishment of independent formal consortia and alliances in the agreement, adoption, and confirmation of technology standards within the wireless power sector. Co-opetition is when normally competing companies collaborate and co-operate on a common goal. The research builds on earlier work observing the effects of interdependent innovation technology standards and, in particular, extends the work of Bar and Leiponen (2014) and Dokko and Rosenkopf (2010).

Access was given to the membership database of 137 members from The Alliance for Wireless Power (A4WP) and permission to directly contact members allowed for both qualitative and quantitative data collection. The quantitative data was gathered of member activity over a three-year period including weekly/monthly meeting minutes, bi-annual/annual general meeting presentations and minutes. The qualitative information was gathered from multiple face-to-face interviews with executives from member corporations. Additional details were collected of member attendance and participation in seven working committees. The impact of the data analysis identified methods of how companies position themselves to achieve influence within standards-based alliances.

This paper contributes to the existing literature and body of empirical studies that examine the relationships between standard setting and alliance development from various industries and products.

Acknowledgements

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For my father...we miss you pal...and for my mother and the memory of her ambition and drive.

Declaration Statement

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Glossary of Terms

3GPP	Third Generation Partnership Project (3GPP) an alliance which set the standards for the 3G wireless infrastructure, 44 members
A4WP	The Alliance for Wireless Power (A4WP) works towards the standards with wireless power, 137 members (as of October 23rd 2014)
AC/DC	Alternating Current and Direct Current electrical distribution methods
Centrality Measurements	Centrality measurements characterizes an important vertex and displays values produced identified rankings
Collinearity and Multicollinearity	Multicollinearity and Collinearity is when two or more independent variables in a multiple regression model are highly connected and you can predict the movement from each other with a substantial degree of accuracy.
Consortia or Consortium and Alliances	An association of multiple companies, organisations or governments joining together in a formal group to execute a common goal
Co-operation	Co-operation (working together) by two or more companies in the attainment of the development of a technology, product or service
Ecosystem	Multiple companies for supply, manufacturing, infrastructure and technology firms involved in the endeavor.
Euclidean Distance	Euclidean distance or Euclidean metric is the 'ordinary' (i.e. straight-line) distance between two points in Euclidean space. With this distance, Euclidean space becomes a metric space. The associated norm is called the Euclidean norm
Fuzzy Kappa	Fuzzy Kappa illustrates the agreement between two categorical theme coders from 'almost perfect to less than change' agreement
Influence	Influence is used within this current research as defined as leverage gained by member firm
IP (Intellectual Property)	Intellectual Property developed and owned by a company or group that is a protected asset. Can be a process, technology or a product that has been patented and is protected
IT	Information Technology industry term
Linear fixed-effect regression analysis	Fixed effects models are non-random and observe each variable represents the observed quantities in terms of explanatory variables that are treated as if the quantities were non-random
Magnetic Induction	Induction transfers power with fixed coupling.
Magnetic Resonance	Resonance power can transfer power without a direct physical contact
NFC	Near Field Communication: wireless transfer of payment for point of sales units
Ordinary Least Squares (OLS)	Method for estimating the unknown parameters in a linear regression
PMA	Power Matters Alliance: Industry standards body
Robust regression	This form of regression analysis is designed to correct errors that occur when heteroskedasticity is presence

Standards	Specific industry specifications or methods in the production or supply of a product or service
Tobit Regression	Also censored regression: a method used to estimate linear relationships between variables when there is either left- or right-censoring in the dependent variable
Wi-Fi	Standard that support local wireless communications for consumer devices
Wireless Power	Traditionally electricity is transferred from a wall socket via a wired/plugged connection, Wireless Power is a technology which transfers power wirelessly
WPC	Wireless Power Consortium: Industry standards body

Chapter One: Introduction

This chapter provides a roadmap for what to expect from this research, and it gives a description of what the research sought to answer, how the study was conducted and the importance of the subject. It provides background information about Industry Standards and Alliances and the specific industry covered in this research (Wireless Power).

This thesis is structured as follows:

Chapter 1	Provides a background to the study and the author's connection to and the relevance of the subject. Details the intention of the research and the methodology used in gathering data which underpins this current research.
Chapter 2	Includes: A review of existing literature from various industries and the current industry being studied in this thesis. An overview of gaps in the literature and synthesis. A statement of research questions and hypotheses.
Chapter 3	Provides the research design and methodology. It covers the sample and the quantitative and qualitative methodology employed. It includes the pilot scheme results; and the social network connections.
Chapter 4	Provides the testing and review all the data, both quantitative and qualitative.
Chapter 5	Includes a conclusion that summarises results from Chapter 4 and addresses the researches hypotheses, objectives and questions. It also identifies the limitations and significance of the research, and makes suggestions for further research. It summarises the research findings and impact.

1.1 Background on the Study

Alliances and consortia groups form to develop and provide specifications for technologies, products or services to aid large-scale adoption of technologies. These groups are often created from competitors, suppliers and customers who choose to co-operate in the standards process and develop standard-based alliances. The current research examined one such technology alliance involving a new, innovative technology, and it explored the interaction of members in developing agreed-upon standards.

The research investigated how alliance member companies leverage their size, activity or position within formal alliances in order to better serve their own needs, including

developing positions of power within a standards organisation. This research, which included contact with seven committees, examined a database of the activities of 137 member companies, and involved 20 face-to-face interviews with key individuals from The Alliance for Wireless Power (A4WP). The research also involved direct interviews with executives from member companies. The access to the interviewees and membership data occurred from December 2013 to October 2014.

1.2 Background on Industry Standards and Alliances

Significant barriers and obstacles must be overcome for any technology or protocol to emerge as a de-facto standard (Belleflamme, 2002). For example, since the beginning of electrical distribution, standards have been needed in almost every major product and industry associated with electrical products including everything from current, voltage, wiring, and plugs to efficiency and safety (David, 1992). Bringing a complicated technology product to market often depends on an ecosystem of supply, manufacturing, infrastructure and technology firms involved in the endeavour, and they all need to work around the same standards.

Establishing a common industry standard can be an extremely complicated and sometimes turbulent effort for any single company, or group of companies, to achieve. Barriers such as scale, investment of time, money, competitors, branding, manufacturing, alternative products and solutions, R&D developments, and various other issues emerge as complex hurdles. These are extremely difficult obstacles, particularly for a single company that has decided to set a standard alone (Henrichsen et al., 2012). Because of these limiting obstacles, oftentimes unusual company combinations form into groups of competitors openly sharing and collaborating towards a common goal of standardisation (Ceccagnoli et al., 2011). The level of co-operation necessary in standard setting can be a significant change in companies' traditional, highly competitive strategic business approach for bringing products to market (Gossain and Kandiah, 1998). The strategy of participating in alliances can also assist in overcoming regulatory barriers related to monopolistic or collusive activities (Aggarwal and Walden, 2003).

Collaboration between competitors in setting standards is not uncommon or a recent development (Hubert, 1894), and it has been long recognized that these partnerships must be entered into carefully after reviewing all risks (Dussauge and Garrette, 1998).

Each company's executive management team must decide strategically which business method to implement, they must decide if they could attempt a sole venture built around their particular technology advantages, or if forming and/or being part of a competitor-based standards alliance is consistent with their corporate goals. For example, Lei (1993) stated that alliances could benefit a company's ability to expand their own technical position, and that, "senior management can structure their alliances as learning platforms to assimilate new technologies and skills to revitalize their core operations" (Lei, 1993, p.32).

In particular, the current research explores the phenomena of co-opetition within the standard setting process, and how companies can leverage their positions within a standard setting alliance. Zineldin (2004) noted that within the standard setting process, "co-opetitive partnerships have emerged as a more effective response to changed environmental threats and opportunities" (Zineldin, 2004, p.780). Co-opetition is the interdependency between competitors and the establishment of independent formal consortia and alliances in the design, agreement and confirmation of technology standards. Normally competing companies can work for a common standards goal and still compete in the market place. Zineldin (1998) stated, for example, that "Organisations can co-operate and compete at the same time in order to be more effective in the marketplace utilizing a relationship perspective" (Zineldin, 1998, p.1138). Co-operating with competitors comes with a degree of risk, which management must be fully aware. As Hamel et al. (1989) warn, "successful companies never forget that their partners may be out to disarm them" (Hamel et al., 1989, p.133).

In most countries, an informal network of collaborating competitors also presents a real issue of appearing as a possible cartel or legally questionable collusion (Petit and Tolwinski, 1997). The lack of oversight and procedures can lead to unintended consequences when two or more competitors spend time in discussions. Accusations of price-fixing and other illegal behaviours have been known to happen within standard setting groups (Evenett et al., 2001). Narayanan and Chen (2012) noted that oversight is an important challenge for standards alliances. Forming formally structured and independent consortia or associations rather than informal networking is one of industry's responses to gaining the benefits of standard setting co-operation while ensuring procedures are in place in order that no anti-customer, price-fixing, or cartel-like behaviours can be executed (Noran, 2012).

With the increasing speed of technological innovations, and the need to set even more standards, a small but growing set of large-scale empirical studies that examine leveraging among partner alliances is starting to develop (e.g., Singh, 2011). The current research builds on this emerging body of empirical research that examines technology innovation and competitor collaboration in the standardisation of product requirements to assist in market adoption. A recent empirical study by Bar and Leiponen (2014) is particularly relevant. Bar and Leiponen (2014) studied the implementation of the third generation of wireless communication infrastructure, analysing the interaction of 44 involved companies through their membership of 64 committees in the Third Generation Partnership Project (3GPP). They examined the decision-making process of companies in the standards organisation, and claimed that, "firms seek to improve their positions in an interfirm cooperation network. In the wireless telecommunications standard-setting organisation we study, firms develop new technical specifications in small committees. Our panel data analyses demonstrate that interorganisational network connections influence firms' decisions to support committees. Additionally, firms are more likely to support committees when they are technologically distant from the firm that initiated the committee. We argued that standard setting presents opportunities for information exchange and for accessing complementary R&D assets through the cooperation network" (Bar and Leiponen, 2014, p.1). The study by Bar and Leiponen, (2014) identified an important and under researched element of the strategies used by alliance members to position themselves and their own IP into the technical standards while seeking to gain competitive advantages.

The activities and influencing behaviours of companies involved with the standardisation of 'wireless power' is the subject of the current research. Traditionally electricity is transferred from a wall socket via a wired/plugged connection. Technology now exists that can enable the electric charge to flow wirelessly therefore eliminating the need for plugs and sockets. The companies involved in the creation of wireless power products are typically divided into two industry types. The receiver device (e.g. smartphone) is made by one company type and the transmitter device (docking station) is made by a number of other manufacturers (automotive, furniture, office equipment suppliers to name a few). The two different types of manufactures have developed a standards-based approach to overcome the technological complexity,

safety regulations and the need for a manufacturing ecosystem of both transmitter and receiver. The Alliance for Wireless Power (A4WP) was formed to produce the wireless magnetic resonance power standard and all the member data and information was catalogued and empirically analysed in this research. Until its merger in 2015, the A4WP was the largest and most important standard setting alliance for wireless magnetic resonance power.

The quantitative portion of the present research builds upon prior research by Bar and Leiponen (2014) by examining similar hypotheses but within a different consortium and technology of wireless power. The present research also expands upon the Bar and Leiponen (2014) 'baseline' model by examining additional data and hypotheses. In addition, interviews with 20 of the alliance's members allow for a more detailed and sophisticated understanding of the standard setting process that augments the findings of the quantitative analysis. In all, the current research investigated 137 individual member company's contributions, interactions, attendance and activity within The Alliance for Wireless Power (A4WP) consortia and their seven working committees.

The A4WP is an industry consortium focused on the development and commercialisation of magnetic resonance wireless power. Its members are manufacturers of semiconductors, personal computers, smartphones, wireless networks and other related fields. Formed in 2012 by two major smartphone partners, Qualcomm and Samsung, the A4WP was later joined by board members Broadcom, Gill Industries, Integrated Device Technologies, Wi-Tricity and Intel. As of 23rd October, 2014 (the date that data collection for the presented study was completed) the consortia numbered 137 members supporting seven working committees ranging from Technology, Regulatory, Certification and Marketing. The A4WP has annual elections for the positions of President and Chairman, Vice Chairman as well as the committee Chairs and Vice Chairs. During November 2014 the A4WP entered into merger discussions with the PMA (Power Matters Alliance) which resulted in a combined new organisation being announced in November 2015. All data gathered and analysed in this research was collected prior to the November 2014 merger talks and no further access was requested. This reduced any bias that might be associated with firms changing their behaviours knowing that a potential merger was likely.

Previous published work analysing competitive behaviour in standards setting organisations in wireless infrastructure is very limited, and like Dokko and Rosenkopf (2010) and Bar and Leiponen (2014), relied extensively on secondary data. In addition to expanding the Bar and Leiponen (2014) and Dokko and Rosenkopf (2010) studies by collecting and analysing similar secondary data obtained from the A4WP, the current research also involved primary research material, such as face-to-face interviews with key individuals involved in competitive partnerships within the A4WP**.**

1.3 Authors Background within the Wireless Power Industry

During the period of this research the author held a senior executive position with a large technology company, Integrated Device Technology (IDT) in California USA's Silicon Valley. IDT designs and manufactures semiconductors used in multiple communications, computing and consumer applications. Among the technology and product families produced by the company are wireless power semiconductors. Like many in the industry, IDT has adopted a strategy of accessing standards organisations. For example, IDT is a board member of The Alliance for Wireless Power (A4WP). The author held the elected position of Vice Chairman of Marketing for the A4WP (mid 2013-early 2015), a position that allowed participant observation (between December 2013 and October 2014) of the behaviours between competitor members. The author sought official permission prior to conducting the research and is bound by confidentiality agreements.

1.4 Research Aims, Objectives and Questions

The title of this research is 'Investigating the Value of Formal Alliances and Competitor Interdependency in the Development of Consumer Technology Standards'. The current research investigated the attitudes and behaviour of a select group of normally competitive companies and organisations that have agreed to join the A4WP alliance, and co-operatively develop industry standards. The objective of the current research was to identify and understand the following traits of the member companies.

1) The business strategy for co-operation with competitors in standards organisations.
2) The level of member activity in the A4WP to generate influence and standard setting proposals.

3) The attitudes and behaviour of the selected executives in leveraging their company's standards membership for commercial market gain.

The basic focus of the current research was to both confirm the primary findings from the research of Bar and Leiponen (2014) within a different standard-setting consortium. In addition, the findings extend prior empirical research (e.g., Bar and Leiponen, 2014; Dokko and Rosenkopf, 2010) by investigating additional important issues related to the standard-setting process. This study formally investigated if companies leverage their size or position within formal alliances in order to better serve their own needs and become influential in the standards alliance. It sought to identify what attributes of a corporation in relationship networking function to influence power within the A4WP in the determination of the technical standards. 'Power' within standards organisations is defined as influence leveraged in each committee in creating the technical specification included in the standards. In addition to gathering objective data regarding alliance relationships and networking, the study also involved interviewing several wireless power executives engaged in the development and introduction of wireless power technical standards.

This objective led to two key research questions of strategy and size:

1) What strategies are developed by member companies seeking to position themselves into positions of influence within a standards alliance?
2) Do large companies have an advantage due to size and available resources over the smaller member companies who may not be able to support contributing equally to the standard setting process?

1.5 Research Methodology

The vast majority of previously published literature utilise externally available data from public websites. One key gap identified in literature was the lack of access to members and member detailed activities within the alliance. Due to the author's industry position allowed access (given agreed upon limits, constraints, and confidentiality requirements) to 'member only' data and direct member contact for interviews allowing a mixed-method design employing both quantitative and qualitative analyses.

The Quantitative Component: At the time the data was gathered (October 23rd 2014), the alliance had 137 member companies with multiple executives per company attending structured regular committee meetings engaged in both engineering and commercial marketing specifications, discussions and plans. The statistical details of the functions, seven working committees, and the member companies were gathered to perform both regression and social network analyses. A similar procedure as used by Bar and Leiponen (2014) who quantitatively analysed the involvement of 44-member companies in 64 committees by a performing a regression analysis of data consisting of member size and membership tenure, activity in committees, (IP) intellectual property strength and number of direct connections. Given the 3-year history of the data (2012-to 2014), this represents an 'unbalanced panel' type of database, and appropriate regression methodologies were used. This research likewise reproduces the social network analysis and centrality measures from the A4WP membership to determine the primary, secondary and tertiary connections of each member company similar to both Dokko and Rosenkopf, (2010) and Bar and Leiponen (2014).

The Qualitative Component: In order to provide a more strategic understanding of the co-opetition attitudes and behaviours, the current study also involved personal observations and formal face-to-face interviews with a select number of A4WP members. There were various opportunities to observe members both individually and collectively during the calendar of fixed standard weekly, monthly and quarterly meetings arranged by the A4WP. Opportunities for 20 interviews presented themselves during four key events occurring from late 2013 to early 2014. In this period member executives travelled to the events and made themselves available for an interview. These interviews were recorded, and the transcripts analysed.

1.5.1 Interviews-Pilot Study and Confidentiality

The required interaction and access to the sample group adhered to the necessary alliance and university confidentiality agreement. A small subsection sample of six A4WP members were interviewed in a pilot scheme which ensured the testing and refinement of the questions and allowed the ability to amend the nature and methods used prior to interviewing a wider group of executives. Following the pilot test, modifications and additions were added and made. The results of this pilot scheme allowed for the qualitative interview format to be finalised.

1.6 Significance

The research identified multiple significant findings that are of value and interest from both an academic and a commercial standpoint.

From an academic point of view, this research represented both a part replication of an important study of standard-setting behaviours by Bar and Leiponen (2014) within a different consortium, as well as an extension of prior empirical work of standard setting alliances (Bar and Leiponen, 2014; Dokko and Rosenkopf, 2010) by examining additional hypotheses not empirically examined previously in the literature. This study also provides a significant addition to the existing academic research by including a qualitative component not common in prior literature.

Importantly this research was able to collect valuable interview data that was subjected to extensive multiple staged analyses. From the interview transcripts a two-coder system identified the key themes from the interviews. These themes were subjected to co-occurrence thematic analyses and a Fuzzy Kappa test, as well as a cluster analysis. The cluster analysis resulted in a two-cluster solution. Cluster one represents members engaged in a 'technology prospectors' type of strategy, while cluster two represents members identified as following a 'technology sellers' strategy. Additionally, a three-stage analysis was performed: developing a saliency input matrix, graphing the theme relationships with 'NetDraw' and an Eigenvector centrality test on the key eight questions theme topics.

This research also provides new significant longitudinal quantitative analysis of meeting minutes and attendance over a three-year period. This analysis details the methods and strategies member companies engaged in to influence the A4WP and leverage their own company position. Member activities in seven committees were detailed and insights were captured about which company used which methods in weekly/monthly meetings, including by means of attendance, collaborations, and partnerships.

In terms of its contribution to management decision-making, this research provides an important new analysis of the methods and strategies member companies used to gain influence within the alliance studied. Its findings could be used as a potential 'playbook' and resource for understanding the methods those companies have successfully used to achieve a strong return for their investment in a standards

organisation. The adoption of any technology standard in the consumer products industry sector is measured in units sold, popularity and its importance in everyday life. The most successful products are well documented and publicized in the media, thereby making the companies responsible for them well known. Significantly, this current research explored the motives behind competitor interdependency in creating formal technical standards focused on the development of a new disruptive consumer technology in the wireless infrastructure industry.

This study examines a significant new industry, Wireless Power, which is at an early stage of market adoption. Consumer awareness and demand for wireless power has increased dramatically in recent in years. For example, a recent article noted that, "In 2014, some 36% of consumers stated that they had heard of wireless charging technology. However, in the past 12 months, consumer awareness has grown to 76% in the U.S., the U.K. and China" (Electronics 360, 2015). Figure 6.1 charts a decade of potential growth in market size from the market research company, IHS, they predict the size of the wireless power market at over 14 billion dollars (US) by 2024. This large emerging market is extremely attractive to companies within the consumer electronics industry.

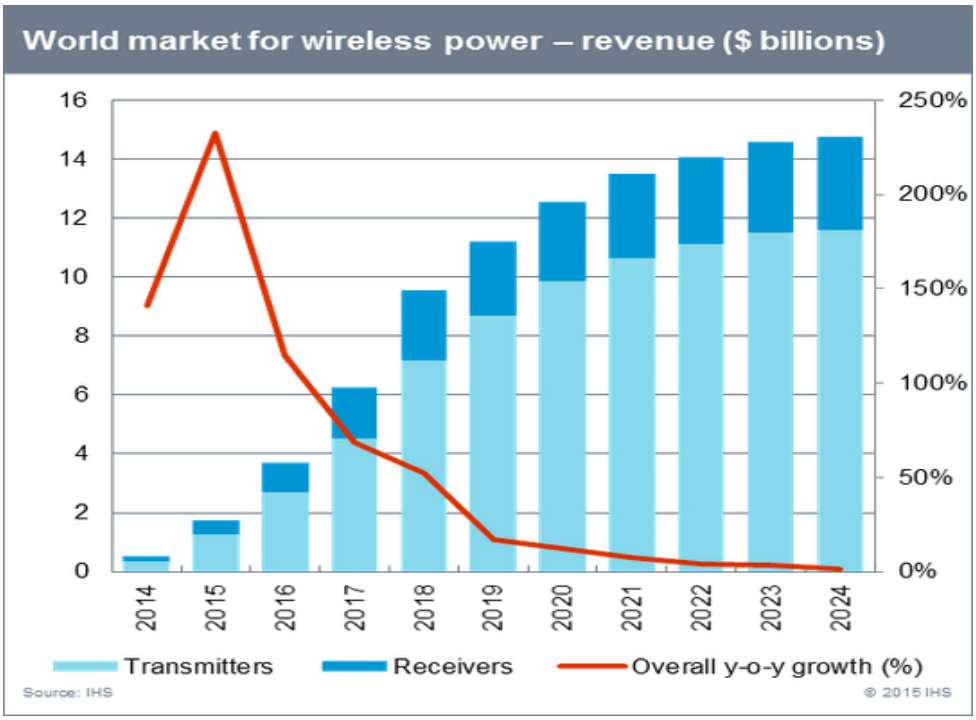

Figure 1 Wireless Power Report 2015 (Source IHS)

Given the importance of this new market, any successful research in the wireless power area could assist senior management and their marketing executives to optimise the launch and positioning of their technology within standards organisations by means of effective active participation in committees and policy setting.

To conclude, this current research contributes to previous literature on standard setting alliances, with a focus on the technology of wireless power. The findings could be used by any company thinking of joining a developing technology standards organisation to maximise their influence.

2. Chapter Two: Literature Review

2.1 Introduction

This chapter reviews the scholarly literature on product standards and the role of industry alliances and consortia in creating standards. This research draws on early understandings of the way individual companies engage in any form of co-operation with potential competitors. This chapter examines both the role of the consumer in accepting successful co-operations and the role of government in developing regulations to ensure correct competitive behaviours and interactions.

In addition, this chapter draws extensively from the standard setting process in technology industries, particularly the Information Technology (IT) industry, as this industry is a key adopter and creator of standards in its development of interoperable ecosystems of manufacture, infrastructure and service for product introductions and support. As the current research is focused on the implementation of the new disruptive technology of 'Wireless Power', the literature on Wireless Power is centrally discussed as an example of a disruptive technology.

The outline of Chapter 2 is as follows

1. What are Technology Standards
2. Why Technology Standards are Needed
3. How Technology Standards are Developed
4. Consumers and Government's Involvement in Standard Setting
5. The Behavioural Drivers of Standard Setting Alliances
6. Models of Standards-Based Alliances
7. Prior Standards Setting Empirical Research Analysis
8. Examples of IT Technology demands for Standards Setting
9. Background details of Wireless Power Technology and Standards Setting
10. Literature Synthesis, Gaps and Research Question and Hypotheses

2.2 Technology Standards

Technology standards are the exact technical specifications and protocols that enable device manufacturers to build their consumer devices fit for function. Krislov (1997) described standards as omnipresent in everyone's everyday living but without much awareness, things like "basic weights and measures or complex and specialised -what is

an acceptable flush toilet? What types of paper and what margins meet the official standards" (Krislov 1997, p.7).

Foster (1979) stated that the demands for safety and supply spurred by the coming of the electrical age in the mid 19th century lead to vigorous standards discussions. Electrical systems were being implemented in the developed world requiring suppliers and manufacturers to manufacture within a common specification. Griffiths (1932) stated even in the early 19th century serious efforts were being applied to the complicated issue of common practices in the manufacture of electrical and magnetic systems. Putman and Clem (1934) saw that industry was beginning the creation of standards and that they saw pre-standards specification being offered to industry for "an opportunity to become familiar with these recommendations and to offer helpful criticism before action on final standards is taken" (Putman and Clem 1934, p.1594).

Standards are often the default method used when devices are interoperable with another product or service. Products that are intended to work with another are commonly designed following the specifications of a technical standard to ensure they are able to function together, products like smartphones are now designed to comply with charging, Wi-Fi, Bluetooth and other software standards. Lehr (1995) discussed standards that are designed to include interoperability functions as harder to achieve, "the requirement to demonstrate interoperable implementations may increase the difficulty or reaching agreement on a standard" (Lehr 1995, p.138).

2.3 How Technology Standards are Developed

Technology standards are developed and accepted through a number of important mechanisms and market forces. These include the force of consumer choice within the marketplace, the impact of technology standard decisions by government agencies, and co-operative alliances of firms for the purpose of setting technology standards. This third mechanism is the primary focus of the present research.

2.3.1 The Role of the Consumer in Standards Setting

This section addresses the role of the consumer in establishing standards. The role of the consumer and the power of market forces can be a deciding factor in the success of any standard has been the focus of many studies. In the 1990s, The Institute of Electrical and Electronics Engineers (IEEE) featured an often-cited paper describing how the

adoption of a technology can often occur to a simple, almost random act of luck, or to quote, "a random process that blindly decides the fate of our technological innovations" (Diamond 1995, p.5). Similarly, Cusumano et al. (1992) discussed the role the consumers played in the adoption of a product in their review of two competing models of video recorders, VHS and Beta Max. They stated Sony's product Beta Max was the earliest to market, but the VHS technology was produced by multiple companies gained greater market share. Sony was the sole manufacturer of the Beta Max system, and the ultimate failure of the product is often cited as an example against independence. It may also be argued that strong marketing by collaborative manufacturers of VHS created stronger consumer identification and branding even though Sony was also very aggressive in its marketing, and, "although it is sometimes argued that the dominance of VHS resulted from the random association of VHS with a more aggressive licensing and pricing strategy, we have shown the pricing and promotion of the two formats to be closely matched" (Liebowitz and Margolis 1995, p.17). Convincing customers through aggressive marketing that your technology will emerge as the predominant standard is key (Shapiro and Varian, 1999).

The average consumer viewed the two products as extremely similar, with both offering common features, but VHS achieved higher units sold and rate of market adoption due to the consumer being able to buy and choose from multiple manufacturers and models. As Liebowitz and Margolis (1995) note, "VHS and Beta were basically identical and that the eventual market choice of VHS was arbitrary" (Liebowitz and Margolis 1995, p.3).

The leading product within the market is often determined by consumer choice, Hill (1997), if the market has two or more standards-based alliances producing a standard, or, as in the case of Sony, a single company going it alone, the 'user' or 'consumer' chooses the winner. As noted, "de facto standards emerge from standards competition as firms offer incompatible technologies, and user choices determine the outcome of the competition" (Techatassanasoontorn and Shuguang, 2011, p.2). The argument that consumer choice, and not third-party standard-setting organisations, will ultimately drive the market adoption and creation of de facto standards has been explored in a number of articles (Arthur, 1988; Stango, 2004). Under this 'consumer choice' model, it can be argued that a major product or company can have standards conform around its needs without initiating collaborative behaviour (Schilling 2002). Aggarwal and

Walden (2003) stated "consumers do not usually buy standards, but rather purchase a product in which the standards are embedded" (Aggarwal and Walden, 2003, p.50). By influencing standards, single suppliers can gain an advantage by leveraging their position in standards-based alliances and ultimately a large commercial market share.

The role of consumers in standard setting is complex, particularly for consumer-based products and services. While companies can form alliances with the explicit aim of establishing a technology standard for mass production consumer devices, in general, the consumer is unaware of these efforts and makes buying decisions independently. In addition, consumers may not be fully educated about, or even aware of the underlying technology. Under these conditions, consumers will develop purchase behaviours based upon price and utility. For this reason, some companies and alliances specifically seek consensus with the consumer in developing standards (Williamson, 2000). In this context, while customers may not be knowledgeable of any standardisation alliances, they can benefit directly from this collaborative behaviour aimed at delivering and enabling consumer choice of leading products. Chakravarti and Xie (2006) illustrated how consumers are positively affected and depend on the technical details and information in advertisement prior to making their adoption decisions. They studied the buying preference of 181 undergraduates and the impact of information presented by standards and non-standards consumer products and found markets with competing technology standards provide the consumer with the greater amount of decision making information.

2.3.2 Government's Involvement in Standard Setting

Governments can also play an important role in the standard setting process. Large governments are often the primary and early stage end-user for certain products, such as military and medical technologies. By setting required specifications for technology-based programs, standards may be established as contracting firms need to follow the program guidelines. But governments can also become involved in standard setting organisations, sometimes to facilitate establishing the required specifications for a large-scale program, sometimes to simply facilitate the development of technologies destined for future markets, and sometimes to restrict alliance behaviour. For example, Baird's (2007) research included the positive role of government in developing a standard, and how it can positively enable the process by promoting the flexibility of the standards

specification to those wishing to adopt a position. Similar collaboration and interaction between members of a standard organisation is required when the standards organisation interacts with government; the optimal situation as Esty and Geradin (2000) observed, "this requires a flexible mix of competition and co-operation between government actors as well as between governmental and non-governmental actors" (Esty and Geradin 2000, p.235). Alexander and Caravannis (1999) also noted that oftentimes governments want to see standards form in industry, but seek to maintain a controlling role for both issues of consumer safety and potential commercial revenue. Krislov (1997) stated creating and implementing standards is an essential part of nation building.

Political restrictions may increase the government's involvement in standard-setting activities. Kshetri et al. (2011) studied the communist government of China's (PRC) involvement in the third generation of wireless infrastructure, including the awarding of contracts to Chinese companies, and found that, observing that, "the Chinese government has demonstrated a clear bias...distinct institutional processes associated with the Chinese government's support of the domestically developed third generation" (Kshetri et al., 2011, p.399). And as Yao et al. (2009) noted, the Chinese government's involvement often restricts the participation of non-Chinese companies in the standard setting process or, "China's interest in promoting its own high-technology standards must be seen in the context of an ambitious policy for technological development that is intended to make China a world leader in science and technology - and standard - by 2010" (Yao et al., 2009, p.46). Cao et al. (2009) studied China's actions to support entrepreneurial activity by leveraging national support for Chinese technology innovation including involvement in standard setting.

Several authors have also examined the situation in the United States. In his examination of food standards, Nielsen (2010), for example, studied the United States government regulations and international standards, and found that enterprises must be aware and knowledgeable of governmental regulations relevant to each standard. In the implementation and enforcement of these regulations, Nielson found that adherence to regulations can improve consumer communication and can 'eliminate economic frauds' (Nielsen, 2010).

Europe is often observed to have an additional layer of regulatory complexity over the US or China. Because European standards-based alliances may be formed in one small European country, this can raise difficulties in attempts to expand to other European countries to achieve a 'common European' standard. For this reason, Egan (2001) noted that, "without some effort to coordinate different National standards and regulations European markets continued to be fragmented" (Egan, 2001, p.3).

While China, U.S., Europe and other governments have stated objectives of aiding the development of technology standards, not all authors agree with this approach. For example, Baird (2008) argues that commerce is no place for political involvement in standard-setting. Baird (2008) argued that commercial ventures should have a minimum of government oversight, or with respect to standard setting, "governments' intervention should be extremely limited" (Baird, 2008, p.219).

2.3.3 Standard Setting and the Role of Co-Operative Behaviour

The primary focus of the present research is on the third mechanism for setting standards, the co-operative alliances of firms or standard setting organizations (SSOs). Several motivations for co-operative alliances in general have been identified in the literature. First, companies may seek collaboration as a business strategy given its potential to increase the speed of innovation and decrease the time to market for a company's product or service through the formation of alliances. Second, advances in technology, practices and products can be accelerated by multiple, like-minded companies sharing and exchanging ideas and information (Dussauge et al., 2000). Third, when technical advancements scale beyond the means of a single organisation (Hagedoorn and Narula, 1999), larger innovation projects can be completed by leveraging the amount of design and development assets offered by a standards organisation. And fourth, an individual organisation's 'knowledge gaps' may be filled by entering into co-opetition behaviour by joining forces with other technical leaders (Baden-Fuller and Grant, 2004). This presents the possibility of bridging missing pieces in a technical equation, which could overcome any intellectual property issues. Because firms reasonably may be motivated to join and/or co-create a standards-based organisation for the purposes of revenue growth and increased profitability, the question of 'what's in it for me?' needs to be addressed prior to engagement (Hurmelinna-Laukkanen and Ritala, 2009).

Dussauge and Garrette (1998) define strategic alliances as a method used by independent companies to partner with other organizations with complementary skills or resources to jointly achieve a solution to a business opportunity. This combination and engagement of normally competitive companies requires the individual companies to consciously examine what are the benefits/costs of cooperation and the necessary strategic changes to make it happen. For example, a review of Fortune 500 companies identified three broad elements/dimensions of standardisation within the marketplace: 1) promotion standardisation, 2) product standardisation, and 3) distribution standardisation, and that impact of these components on standardisation vary depending on the industry (Waheeduzzaman and Dube , 2003).

Baghbadorani and Harandi (2013) found four active contributing elements in the establishment of standards in competitive alliances: 1) the leaders, 2) the contributors, 3) the users, and 4) the environment. They looked at each 'building block' in the achievement of a successful implementation of a new standard. In this process, members of the standards organisation contribute their particular knowledge for each discipline or expertise, noting that, this allows the alliance to achieve a wider range of activities. Hearn and Pace (2006) looked specifically for 'value-creating ecologies', and identified five shifts or necessary changes in their conceptual study of the creative industry. Two of the shifts they identified speak directly to the growth of an ecosystem and standards, that is, "the shift from thinking about simple co-operation or competition to complex co-opetition; and the shift from thinking about individual firm strategy to strategy in relation to value ecologies" (Hearn and Pace, 2006, p.55).

In a review article discussing standardisation and market adoption, Nasir and Altinbasak (2009) noted that corporations must assign equal thought to both how the standards alliance membership helps achieve their goals as well as how they are structured internally to be able to take full advantage of the new co-operation environment. The close relationship between external and internal activities have serious impact on the standardisation/adaption (SA) and specifically they investigated the use of the marketing mix as a strategy to impact standardisation/adaptation (SA), both internally and external to each company, in their empirical study of previous academic research on international marketing strategy. They define their model as encompassing environmental factors such as "customer similarity, market similarity, advertising infrastructure and level of competition" (Nasir and Altinbasak, 2009, p.21).

Table 1 summarises their work:

Table 1: External and Internal Drivers (Nasir and Altinbasak, 2009, p.22).

External Drivers	Internal Drivers
I. Economic Climate and S/A Decision • Market Structure • Customer Similarity and Spending Patterns • Competitive Sphere • Human Resource Capital	**I. Corporate Strategy and S/A Decision** • Strategic Orientation • Management Orientations • Marketing Mix Strategy • Foreign Market Entry Mode
II. Technical Expertise and S/A Decision • Level of Technological Development • Technical Readiness • Media Infrastructure	**II. Company Culture and S/A Decision** • Managerial Philosophy • Centralisation and Formalisation • Leadership Style • Country of Origin
III. Political/Legal Factors and S/A Decision • Laws and Regulations • Barriers to Entry	**III. Co. Size and Scope and S/A Decision** • Company Size • Industry Factor • International Experience • Financial Strength

Schmid and Kotulla (2011), in their meta-analysis of over a 50-year period of published research in 143 marketing and business journals covering 330 articles on international standardisation and adaptation, discovered that 87% of published articles over the 50-year period identified that standards can aid individual product adoption in the marketplace. The authors concluded, that the success of standardisation is likely to add profits if six elements were present, (1) a high cross-national homogeneity of demand, (2) a high potential for cross-national economies of scale, (3) a high cost of product

modification, (4) a high foreign price elasticity of demand, (5) a small perceptual error of the managers, and (6) a high quality of strategy execution.

One important trend noted is that with the development of more technology-driven sectors, there appears to be an increase in 'co-opetition' behaviours within organisations. For example, Brandenburger and Nalebuff (1997), in their 1997 book entitled 'Co-opetition a Revolutionary Mindset That Redefines Competition Cooperation', argued that co-opetition is a strategy that's changing the game of business.

Prior research on firms' motivations in competitive alliances (not just standard-setting) includes examining both technology and non-technology companies. This broad, alliance-building literature is relevant to the current research as the literature addresses the motives for companies who feel the need to join in a co-opetition nature to expand innovation and market adoption (Adner, 2006; Hagedoorn, 1993). Accelerating or expanding technical innovation may be one motivation for alliance as technology development is both expensive and a new, innovative technology often needs a formal standard to support implementation against an older, more established technology. Under these conditions, companies are less bound by their size and ability to innovate, "the link between firm size and innovation are outmoded because the boundaries of the firm have become fuzzy in recent decades. Strategic alliances — constellations of bilateral agreements among firms — are increasingly necessary to support innovative activities" (Teece, 1992, p.1).

From a general alliance perspective being positioned correctly, such as accessing first mover advantages, within a market-based network can accelerate an organisation's performance by increasing the scalability of their product, service or technology (Hagedoorn and Schakenraad, 2006). For example, Wang et al. (2010) researched the 'Network Effect' (NE) and empirically examined data from 45 network effect markets. They looked at NE's potential negative or positive impact on either single or multiple product ranges. Their results showed that, if the network was strong, the early adopter advantage weakens with the arrival of more member companies. They found that, "on average, pioneers experience a survival disadvantage compared with early followers in these markets" (Wang et al., 2010, p.8).

Murray et al. (2012) studied alliance data encompassing over twenty-five thousand foreign businesses in China, and these researchers' findings point to a firm's trade-off between going it alone and the amount of market share it would potentially curve out. The authors found that, early members achieve greater market share but lose out to late adopters over time. These results support evidence of the, "interaction effects among entry timing, entry mode, and investment size on foreign firms' market shares and survival" (Murray et al., 2012, p.50). Thus, it appears that companies may find an advantage in early engagement, when an ecosystem is being established, and they can leverage that position.

Adner and Kapoor (2010), in their study of nine types of semiconductor standard processes over a 40-year period, noted that the power or influence each member company can exercise relies on the importance of the contribution and companies' market position. But critically they identified that location within the ecosystem favour local firms. In addition, late adopters of standards alliances have access to a more established market than early adopters, and possibly can receive a higher return for reduced cost and time investment (Wang et al., 2010).

2.4 Structured Technology Setting Alliances

2.4.1 Types of Standard Setting Alliances

There are two basic forms of collaborating strategies that present themselves as options for standard setting: 'informal' competitor alliances and 'formal' standard setting organisations (SSOs).

Informal Alliances: Groups of companies that hold meetings concerning a common industry challenge or need without rules or structure are seen as informal alliances. Several problems have been noted with informal alliances. From the risk of 'cheating' or an opportunistic member developing non-cooperative activities is high. In addition, informal alliances may be seen as developing cartel-like behaviours where best practices and customer care may not be followed. Petit and Tolwinski (1997) analysed the negative effects of 'technology sharing cartels' and the behaviour of casual business co-operation as giving the appearance of collusion against the customer for profit. Evenett et al. (2001) uncovered 40 prosecuted examples of illegal cartel activity from normally competing companies forming informal alliances rather than entering into formal standards bodies, noting that the consumer may suffer with choice restrictions

and increased prices. Delcamp and Leiponen (2014) analysed membership data from 32 technology alliances over a five-year period and found cases of informal alliances that existed between groups of companies, both direct and indirect competitors, but these informal groups were not open to the public: "informal consortia are private organisations, little is known about the nature and topics of discussion, decision-making procedures, or forms of information exchange" (Delcamp and Leiponen, 2014, p.36). Informal partnerships and co-operation come with potential regulatory infringement dangers (Hurmelinna-Laukkanen and Ritala, 2010). Lei (1993) focused on how senior technology management can structure their alliances, and claimed companies that embark on alliances without acknowledging the risk of skill transfer are 'likely to lose' (Lei, 1993).

There is also difficulty for an informal alliance to process the amount of dynamic information needed in standards creation. As Noran (2012) observes, "standards typically used as pillars for enterprise and network management and (inter)operation are themselves subject to continuous change and often bring their own interoperability, inconsistency and overlap problems" (Noran, 2012, p.327).

Saarinen (2009) examined data from a 39-year period from 1945 to 1984 involving 1600 companies, and noted that informal alliances are not preferred. He found that, "as cartels become less acceptable, later on even forbidden, by law other forms on networking increased their importance" (Saarinen, 2009, p.138). Formal rules for competitive engagement offer management the safest way to conduct their business when engaged in standards activity, and government oversight can have a positive or negative impact.

Formal Alliances: Groups of companies with common interests and challenges within an industry often form official structured alliances (SSOs) with membership policies, rules of engagement, stated goals, etc. These formal alliances have emerged as the operational model which controls all participant behaviour within correct business procedures (Iansiti and Levien, 2002). Forming official, formally-structured and independent standards-based alliances is one response by industry to gain the benefits of co-operative technology standard discussions within a competitive market ecosystems while ensuring regulatory procedures are in place (Geradin and McCahery 2004), and that no anti-customer behaviour can be executed (Narayanan and Chen, 2012).

Establishing formal standard-setting organisations is often used as a structured method of addressing intellectual property usage within the technology industry (Lemley, 2002).

Forming and/or belonging to a standards-based alliance can impact the existing go-to-market strategy of a company. Management must be aware of the possible effects of a formal alliance on a number of issues, such as end-market position, R&D and production capacities, company performance and competitive advantages. Hagedoorn and Narula (1996) researched how companies have been known to address their internal organisational structure to support such strategic behaviour. For example, technical organisations have structured separate engineering teams in some cases (Zakrzewska-Bielawska, 2013), while others have appointed separate teams to work with the competitor's management (Clark and Dietrich, 2001; Gurău et al., 2013). New members to any standards-based alliance must re-address their strategic plans post-membership, as their market strategic position may have altered (Iansiti and Levien, 2004). Management have a real obligation to consider all the risks versus benefits, to carefully develop a strategy to support competitive ecosystem behaviour (Gueguen et al., 2006), and to correctly support the necessary inter-firm transfer of information without giving up their own competitive position (Hagedoorn, 1990; Tsai, 2002).

2.5 Models of Formal Standard Setting Alliances

2.5.1 Formal Standard Setting Alliances: Co-Operation and Equilibrium

In the 1997 book called 'The complexity of co-operation: Agent-based models of competition and collaboration', Robert Axelrod, using a game-theoretic model, described the complexity of competitor co-operation, inferring that competing companies may still serve their own needs over the joint needs of the standards process, even though some co-operation may result in greater benefits. However, if the companies resist the attraction to simply compete, and don't betray each other (change their strategy) for personal gain during periods of co-operation, they can put themselves in an even stronger position compared to acting alone.

As an extension, Nash's equilibrium represents an method of predicting an equilibrium point of 'success' among multiple 'players' under the conditions typically seen in industry co-operative situations, that is, when players are assumed to know the equilibrium strategies of other players, and no player can gain additional benefits by

changing their own strategy. Nash equilibrium is often referenced in the case of several companies engaged in the implementation of a standards alliance. In these situations, the individual corporations have their own strategic goals and may form co-operations with other companies as a natural progression without additional incentive benefits being offered (Felegyhazi, et al., 2006). As a case in point, Bar and Leiponen (2014) recognized that each relationship in the standard setting alliance's committees they reviewed created a type of prisoner dilemma situation, that is, "we assume that each committee constitutes a Nash equilibrium: fixing the behaviour of all others" (Bar and Leiponen, 2014, p.7).

Alliances are formed from multiple organisations that, although typically sharing a stated aim or goal of standardisation, have no guarantees that member companies always will co-operate. "One might justify the co-operative equilibrium on 'efficiency' grounds, but one cannot guarantee that co-operation will prevail in every sequential equilibrium" (Kreps et al., 1982, p.251). This has raised the importance of both descriptive and empirical research into the issue of standard-setting alliances.

2.5.2 Formal Standard Setting Alliances: Economic Theory of Clubs

One can also think of a voluntary standards alliance as an 'economic club', that is, a mutual benefit organization where members share the costs and oversight of the organization. Cornes and Sandler (1996) defines an economic club as a voluntary group of individuals or firms who, "derive mutual benefit from sharing one or more of the following: production costs, the members' characteristics, or a good characterized by excludable benefits" (Cornes and Sandler, 1996, p. 347). If a standard setting alliance can be considered an economic club, sharing occurs at several levels, including the costs associated with creating, managing and selling a particular set of 'standards'. In this sense, the 'club goods' are technology 'standards' with the excludable benefits being non-alliance firms' lack of access to the standard specifications and early knowledge leading to the development of technology standards. Knowledge of an industry standard has characteristics of being both a 'public good' and 'private good', or what is often referred to as an 'impure public good'. Standards knowledge is indivisible, a key element of a public good, but there are elements by which this knowledge can be appropriated by the provider, a characteristic of a 'private good'. Club theory provides

a model for understanding the allocative efficiency of these "impure public goods" (McNutt, 1999, p. 936).

James Buchanan (1965), in his seminal 1965 article titled, 'An Economic Theory of Clubs' notes that certain groups (clubs) are often more efficient at allocating resources than the open market. In early periods of the club growth, new members are generally welcomed particularly entrants that don't threaten the existing members. However, when a club grows too large then inefficiencies may start to develop. In club theory, 'congestion' refers to a general type of crowding that occurs when membership grows to the point that the benefits of club activity begins to diminish (for a discussion of 'congestion' see Sandler and Tschirhard, 1997). When this type of 'congestion' occurs, new entrants are often seen by more tenured members as 'free riders', taking advantage of the club without having paid the 'dues' of earlier involvement and contribution (see Buchanan,1965; also Zaleski and Zech, 1995; Maier-Rigaud et al., 2010; Chakravarty and Fonseca, 2017). In some cases, the club may then set barriers or discriminate against new entrants. It is interesting to note that a 'free rider' problem could also possibly occur when small firms are part of an alliance that also has larger members, but where the larger members contribute more than a proportional share of the alliance's effort (Sandler and Cauley, 1975). Not surprisingly, the issues of optimum club size are a dominant theme in the economic theory of clubs literature (see Tutić, 2013).

As Chakravarty and Fonseca (2017) note, "club goods, when financially effective, can work not only as an expression of a sense of group identity, but also as a mechanism that enforces cooperation at the population" (Chakravarty and Fonseca, 2017, p. 258). Since most standard setting alliances are initially established by large firms, at the beginning these can be considered 'homogenous' clubs. However, since there are probably large scale economies to achieving market adoption of a standard (particularly if there are competing standards from different alliances or large 'go-it-alone' firms), there is a strong incentive to expand membership to other types of firms, such as smaller entities, that may not challenge the early status of larger firms. Thus, over time, as an alliance matures it may take on more of a 'mixed' club orientation. Mixed clubs are recognized as being more desirable when there are large scale economies (Sandler and Tschirhart, 1980; McNutt, 1999). This has direct application to the general notion of how standard setting alliances develop and behave.

2.6 Empirical Research: Formal Standard Alliance Influence and Processes

Most of the empirical research described on standard setting has focused on how standards are accepted in the marketplace, how firms develop strategies to gain adoption, and whether a firm adopting a standard is successful. Due to the difficulty of obtaining internal and oftentimes proprietary data, to date only a handful of SSOs have been empirically investigated by quantitative modelling, and most of these published studies have focused on social welfare issues or voting behaviour, not on the key strategic issue of firm influence. The majority of the published empirical studies on SSOs have used data from the 3rd Generation Partnership Project alliance (3GPP) in mobile telecommunications, a database that has been recently made publicly available for use by researchers (Leiponen, 2008, Bar and Leiponen, 2014, Baron and Gupta, 2018, Kang and Motohashi, 2015). Studies using the Internet Engineering Task Force (IETF), an open-source standard setting alliance, include Waguespack and Flemming's (2009) study of "time to liquidity" for start-ups and Simcoe (2012)'s examination of "standard setting delays." Dokko and Rosenkopf (2010) and Gandal et al. (2004) both used data from the Telecommunications Industry Association (TIA), while Ranganathan and Rosenkopf (2014) examination of "standard proposal voting behaviour" used the InterNational Committee for Information Technology Standards (INCITS).

The two major published studies examining influence within a standard setting alliance that are relevant to the present study are Dokko and Rosenkopf (2010) and Bar and Leiponen (2014). These two studies represent a 'baseline' for the present research.

2.6.1 Prior Empirical Research: Dokko and Rosenkopf (2010)

Dokko and Rosenkopf (2010) examined two large committees (TR-45 and TR-46) of a standard setting organisation in the U.S. cellular telephone industry, the Telecommunications Industry Association (TIA). The researchers had access to a variety of internal documents, committee rosters, and reports. They examined ten years of data, covering 936 meetings, resulting in a panel data set of 186 firms. Dokko and Rosenkopf (2010) examined firm influence with two measures: a) projects undertaken in the alliance that contained a firm's patents, and b) if a firm was an 'editor' of a project initiation form. This second measure is most similar to the variable used in the present research, or 'standard proposal introduction'. Predictor variables included social capital measures (centrality) based upon firm and individual involvement in

meetings, redundant participation, committee chairmanship, prior year involvement (experience), patents, and other control variables such as size. While Dokko and Rosenkopf 's research focused on the flows of personnel, they found social capital, redundancy, firm size (reverse), patents, and experience related to influence within the standard setting alliance.

Dokko and Rosenkopf 's research highlighted the issues of not retaining key executives and possible loss of advances from member firms if their personnel is not consistent and noted, "Losing employees can affect firm influence via the same firm social capital mechanism as hiring people, i.e., when exiting employees change the relationships between firms" (Dokko and Rosenkopf, 2010, p.680).

2.6.2 Prior Empirical Research: Bar and Leiponen (2014)

Bar and Leiponen examined the 3rd generation wireless infrastructure implemented by the Third Generation Partnership Project (3GPP) as it was developed and introduced. The study focused on attempts by member companies to gain influence within committees that develop the standards specifications. Gathered from public member online available data, Bar and Leiponen studied the committee structure and the sphere of influence of each member of the 3G Wireless Telecommunications standards. Their study involved several steps: First, based upon committee membership, the authors performed a form of Social Network Analysis (SNA). They gathered membership connection points from the membership data and committee structures. They defined 'Primary' contacts as those companies that share a committee, 'Secondary' contacts as sharing a membership category and finally 'Tertiary' contacts are members from the same alliance. This data was used similar to Dokko and Rosenkopf (2010) as a centrality measure for the identification of influencing companies and the illustration of clusters as to how the firms were related within the social network for standard setting committees. Second, Bar and Leiponen then explored if members used their size or number of contacts to influence the alliance. They compared and contrasted this data with the activity of each member company, and established that the companies leveraged the amount of primary contacts to increase their role in the most important committees within the 3rd Generation Wireless Infrastructure.

Figure 2 below illustrates the member's interaction and connections through their committee attendance within the four committees in the Third Generation Partnership

Project (3GPP). It highlights the member companies that have a direct primary contact/interaction within the group and those who do not interact and only have a secondary contact due to membership. The current research used a similar model (UCINET software in Figures 9.10 to 9.16) to identify the connection points of each member company within the A4WP seven working committees.

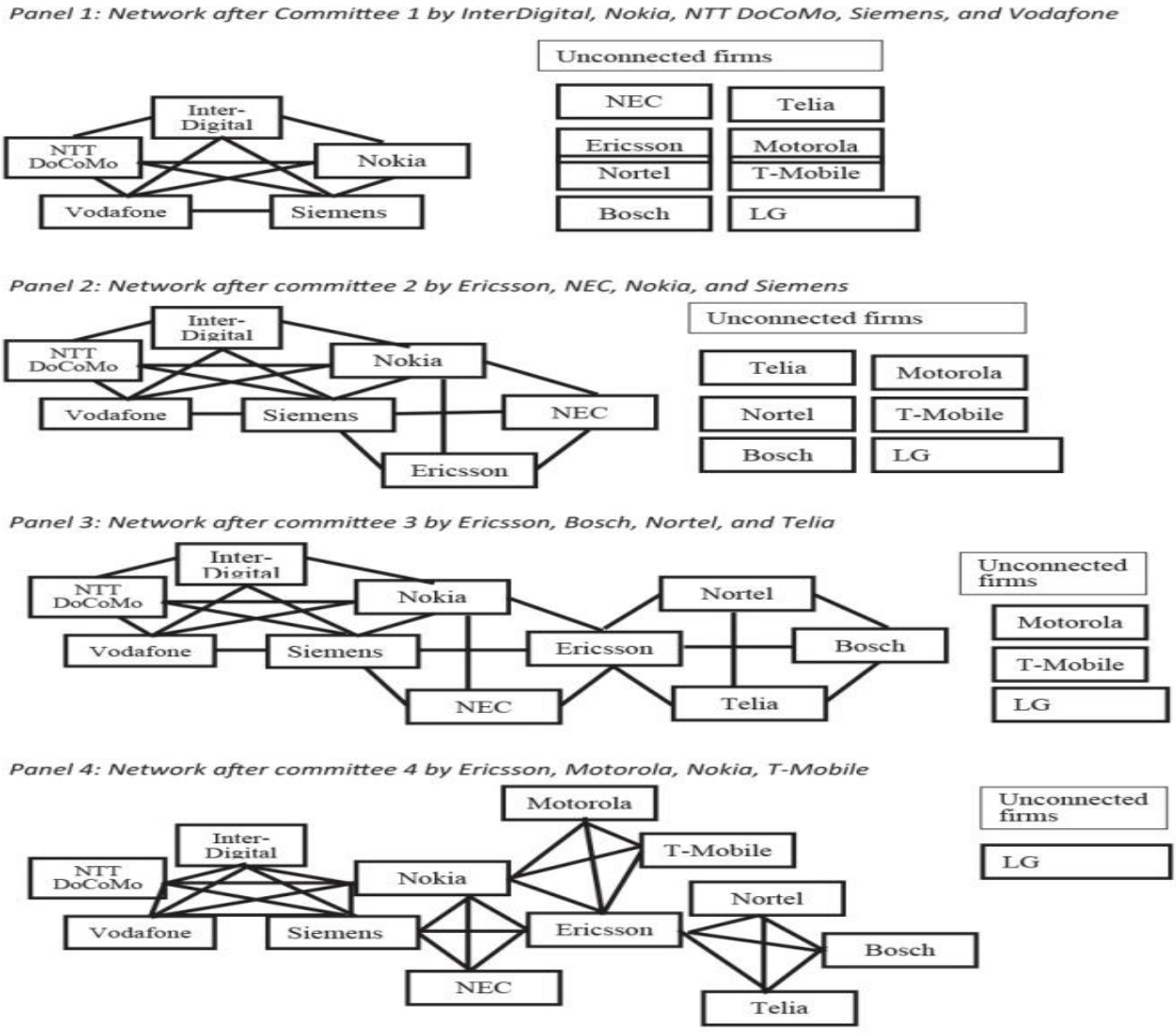

Figure 2: Bar and Leiponen (2014) SNA Graph of 4 Committees (Bar and Leiponen, 2014, p.8).

Figure 3 displays the entire 64 committees of the 3GPP standards organisation and illustrates the interaction touch points between each company. Again the current research used UCINET software to perform a similar analysis to map the connection points of A4WP in Figure 22.

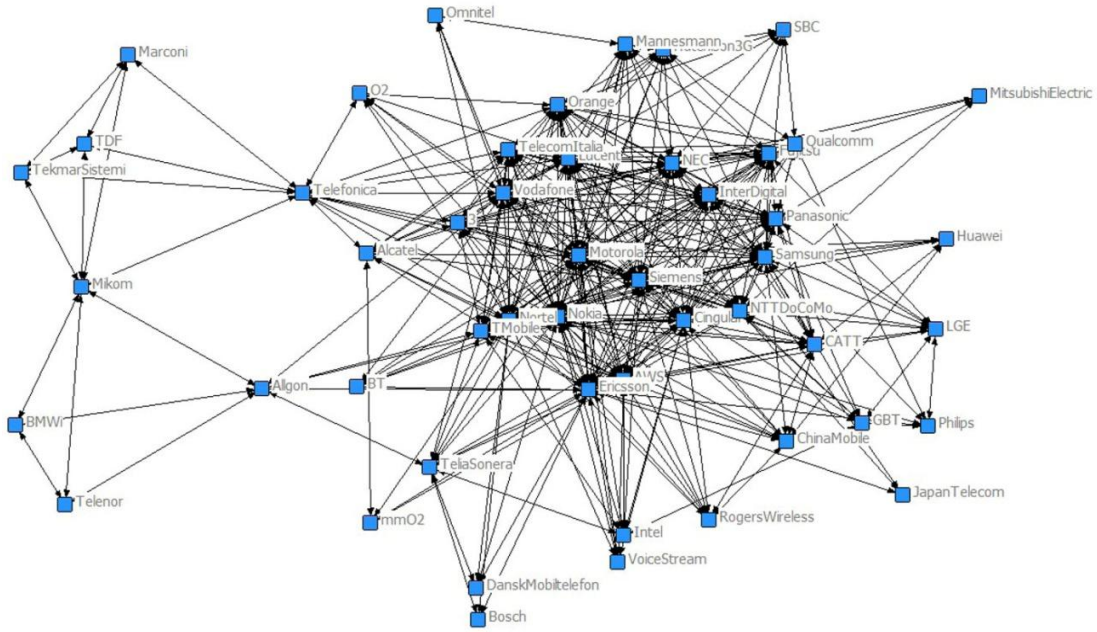

Figure 3: Bar and Leiponen (2014) SNA Graph of Committee Member Interaction, Overview of the 64 committee members (Bar and Leiponen, 2014, p.9).

Bar and Leiponen's (2014) desire was to show that member firms seek to position their products, services and IP in prominent positions within the 3GPP by gaining primary connections through active committee attendance. Bar and Leiponen (2014) named the active committee members as 'supporters' and non-committee member companies as 'sources'.

The research of Bar and Leiponen (2014) contributed significantly to the empirical literature on co-operative standard setting, and offers examples of members leveraging network connections, committee affiliation, and important strategic information exchanges between business leaders. Using actual committee membership data, the work carried out by Bar and Leiponen (2014) was significant in identifying firm's motivations in contributing to the work of the committees and how members value connections with peers that improve their position. These connections are often valued greater than IP and market position that previous literature emphasized. The Bar and Leiponen (2014) regression analysis did, however, find that members offered committee work items to benefit their own company's position and technology.

2.7 Technology Standards in Information Technology (IT): An Example

Currently, most industries rely on a degree of standardisation from standards-based

alliances to achieve cross functional performance improvements and rapid market adoption. For example, in the industrial manufacturing industry Ball et al. (2013) found the need to be highly collaborative with competitors in creating an ecosystem, or "crossing the discipline boundaries between building services, manufacturing, operations and facilities brings new opportunities in the way manufacturing systems can be improved" (Ball et al., 2013, p.566). Byrne and Polonsky (2001) addressed a complicated transport issue concerning the adoption of alternative fuel vehicles (AFVs), and stated standards were paramount in overcoming issues including regulatory barriers and resources (Byrne and Polonsky, 2001). Standards development implementation in healthcare, in particular, has produced measurable results in the speed of communications between service providers (Benson, 2012).

The Information Technology (IT) industry is one of the most avid adaptors and promoters of technical specification from standard-based alliances. The demand by consumers for common standards seems to be a driver in IT. Borrows (1999), for example, studied the need for standards in the IT industry and found, "Standards for information technology (IT) systems are important to users in effectively applying IT and carrying out the business of their organisations. Users need standards to interconnect products developed by different vendors and to move software, data and applications from one system to another" (Burrows 1999, p.323). Jiang et al. (2012) found in their research that the need for IT infrastructure to stay ahead of technology advancements is critical, that is, an "effective standards strategy can bring many business benefits and help firms to achieve and sustain competitive advantage development" (Jiang et al., 2012, p.329). Since IT relies on standard platforms for the implementation of upgraded infrastructures, standards are a basic strategy that is often implemented to aid co-operation (Oksala et al., 1996).

This apparent acceptance, prominence and reliance on standardisation within the high-tech field has created a large body of research on the importance of detailed standards, or as Adomavicius et al. (2007) have noted, infrastructure crosses many different technologies and involves a combination of different interrelated technologies (Adomavicius et al., 2007).

2.7.1 Open Source Technology Standards in IT

Recently, various technologies have been at the forefront of adopting open platforms,

with open source software and other IT technologies at the forefront (Yuan, 2007). Open source refers to innovations that can be freely used, changed, and shared by the manufacturer of the technology. In these situations, standards are often set through the back and forth process of open sourcing. Weiss and Cargill (1992) defined open source as a philosophy that allows the "interworking and or substitutions of any component of an IT system" (Weiss and Cargill, 1992, p.559). In open source technologies it has also been noted that the adoption of a platform can influence, and ultimately determine the success of a particular technology (Cusumano, 2010). Querbes-Revier (2011) studied the adoption and success rate of alliances introducing new technologies, and analysed the coherence of these alliances using an open source framework to perform the necessary reconfiguration at both the technological and organisational level. Alspaugh and Scacchi (2012) argued that individual intellectual property advantages may be abandoned in allowing a standard to develop, and that open source software aids faster and more robust IT infrastructures. In contrast, Bonaccorsi et al. (2006) surveyed 150 European companies engaged in software technology development and found both open source and traditional intellectual property standards methods showing, "that firms have adapted to an environment dominated by incumbent standards by combining the offering of proprietary and OS (open source) software under different licensing schemes" (Bonaccorsi et al., 2006, p.1085).

This prevalence of open source standards can allow for increased adoption and market acceptance, but it is reliant on promoting the awareness and availability of the standard (Argam et al., 2011). Eisenmann et al. (2011), by contrast, note that there is an important value in the promotion of open IT standards over an individual company.

2.7.2 Innovation and Technology Standards in IT

The importance of the need for technology standardisation in IT industries has increased over time. For example, Hawkins (1999) research on the rise of standards alliances in IT industries suggested that this increase was due to both the complexity of innovation needs and the infrastructure required in IT standards. Similarly, Updegrove (1995) argued that working with IT protocols, such as those from Microsoft, large groupings of companies were necessary in developing technology standards. Chen et al. (2012) produced a comparison model of technology standards and technological innovation. They developed a volatility model of technology standardisation, and noted the need for

co-operation within a wider group of companies. Their analysis did find a link between volatility and alliances, and concluded "there exists a co-operative effect between technology standardisation and industrial technology innovation" (Chen et al., 2012, p.251). The co-opetition interaction is an important and different way to behave in businesses affected by emerging technologies. Garraffo (2002) suggested the idea that within emerging technologies there is a 'network of innovators' which focuses on accessing developing new technology marketplaces.

2.8 The Sample Technology: Wireless Power Electrical Distribution

Wireless power represents an innovative approach to transmitting electricity, and is the focus of the present study. In fact, electricity itself represents one of the great stories of standardisation involving the development of the electrical current standards of 'alternating current and direct current'. The need for a single standard or method appeared at the very invention of electrical distribution and the discovery of its commercial possibilities (Foster, 1979). The early potential of electrical distribution was publicized by its two innovators, each supporting different emerging standards; Thomas Edison was in favor of direct current (DC) distribution while Nikola Tesla supported alternating current (AC) distribution. Both McNichol (2006) and David (1992) saw the highly publicised conflict between Edison and Tesla as not only a war of two innovators and their investors to win commercialisation (as commonly viewed), but also a classic battle to establish a market standard that involved the use of technical advantages, costs and safety. Edison especially used the safety concerns of electrocution to attempt to scare and raise the awareness to win public opinion in attempting to establish his particular standard (Hubert, 1894).

2.8.1 What is Wireless Power?

Traditionally electricity is transferred from a wall socket via a wired/plugged connection. Today, technology exists that can enable electric charge to flow wirelessly, therefore eliminating the need for plugs and sockets. Even with this activity, market adoption has eluded even some of the largest companies in the world (Georgiadis, 2008). The ability to transfer power wirelessly is seen as a desired feature by the consumer, but the beneficiary of successful standardisation is often unaware of the activity of competitors in the creation of standards (Chakravarti and Xie, 2006).

Still relatively new in its development and market adoption, wireless power technology is not new; the technology has been known since the mid-1800's. By the turn of century, the early innovators of electricity distribution, Michael Faraday and Nicola Tesla, had demonstrated its potential in their inventions. In a 1904 interview Nicola Tesla stated that electricity would be transferred without wires even over vast distances (Tesla, 1904). He even constructed a large tower near New York designed with the bold objective of transferring electricity wirelessly over the Atlantic.

There are two leading methodologies in wireless power technologies and wireless electrical transfer innovation: 1) magnetic resonance and 2) magnetic induction (Kurs et al., 2007). Magnetic resonance transfers power with no physical contact of sources and has been known from the early nineteenth century. As Waffenschmidt (2011) notes, "since the early times of inductive power transmission by Nicola Tesla, resonant operation is used to improve power transmission. Resonant power transmission is more than 120 years old!" (Waffenschmidt, 2011, p.1). Resonance technology allows for power to be transferred over distance without wires or direct contact on the receiver and transmitter field (A4WP standard).

The other wireless power technology is induction. Induction technology, however, requires a fixed coupling of two coils and requires the transmitter and receiver to touch but without the use of wires or plugs (WPC and PMA standard).

Both resonance and induction transfers power at a matched frequency. Resonant technology depends on a higher frequency 6.78MHZ to travel over distance (Slichter, 1990; Cannon et al., 2009). The tightly coupled induction technology transfers power at much lower frequencies, around 150-200 KHZ (Oleson, 1982; Boys and Green, 1996).

Businesses and markets have been formed around each of the technology choices, with an overall objective of advancing the technologies and finding appropriate applications. For example, the department of Electrical and Computer Engineering at Duke University has independently tested wireless charging up to ten watts. The Duke team created a 'Duke SmartHome' which created a wooden cabinet that was able to transmit tens of watts of electrical power to power multiple devices simultaneously including an alarm clock, a USB light, a LED, a USB toy and an iPhone, (Teo, 2010). Interest in the principles and development of wireless power continues alongside commercial interest in applications in popular consumer technology devices. As Slichter noted that there is

vigorous activity focused on magnetic resonance producing many new proof of concepts and applications, (Slichter, 1990). The significance of wireless power for the consumer and the amount of recent developments were stated in a 2015 Institute of Electrical and Electronic Engineering paper it is noted that, "magnetic resonance is the technology which could set human free from the annoying wires...WPT (Wireless Power Technology) is developing rapidly in recent years" (Li and Mi, 2015, p.4).

University-based research has positively assisted the commercialisation process, and in some cases, has resulted in university spin outs. For example, Gozalvex (2007) noted a team from the Massachusetts Institute of Technology's (MIT) Department of Physics, Department of Electrical Engineering and Computer Science, and Institute for Soldier Nanotechnologies (ISN) demonstrated the transfer of electricity to wirelessly power a 60 W light bulb over a distance of more than two meters, (Gozalvez, 2007). This academic team then became a commercial venture 'Wi-Tricity Inc' which is a board member of The Alliance for Wireless Power (A4WP) and is a key contributor the technical standardisations and establishment of wireless charging in consumer products. The MIT team refers to its concept as 'Wi-Tricity' (as in wireless electricity). Wi-Tricity is based on using coupled resonant objects.

2.8.2 Standards Setting in Wireless Power

As with previous technologies, the specific use of alliances with wireless electricity technologies allows standards to address a variety of sensitive and significant issues that related to the technology and its commercial development. Standard-setting organizations have formed around each of the two wireless power technologies.

The Institute of Electrical and Electronic Engineers (IEEE) ratifies and confirms proposed technical specifications from alliances. This type of technology institute plays a vital role in independently validating and certifying new electronic technologies similar to NFC, Wi-Fi, Bluetooth and Wireless Power (Gelman et al., 2009). Lee and Verma (2011) have stated the importance of standard-based alliances in addressing the varied elements of technology specification, and have noted, "various standardisation activities in progress by industry alliances and international standard organisations to assuage the bandwidth paucity problem by defining protocols for Wi-Fi operation" (Lee and Verma, 2011, p.213).

2.8.3 Wireless Power Technology- Going it alone... the mighty Apple

In April 2015 Apple Inc. began shipping the first consumer device with wireless induction charging, the 'Apple iWatch'. They decided not to use the WPC or PMA standard for magnetic induction, but instead use their own proprietary non-interoperable technology. Apple included the wireless charging receiver in the watch and provided the power transmitter in the watch base holder. This new category of consumer devices is now referred to as the 'Smart Watch' market and is dominated by Apple and Samsung (Samsung adopted the WPC standard for its wireless charging).

Apple has used a strategy of developing a unique technology separate from accepted standard-setting processes in prior technologies. For example, in late 2007 they introduced the 'iPhone', which came with a unique connector. Just as the smartphone industry was solidly using the micro USB connector, Apple did it again with the 'iPhone 5'. When it was introduced in November 2012, it came with yet another all new connector, the 'Lightning connector', which was different from any other phone. An online consumer site www.pcmag.com stated that the new cord would cause massive consumer annoyance because it did not make the device interoperable with other consumer products (Lendino, 2012). But in a PC Mag article Lendino (2012) suggested a plausible reason for Apple risking upsetting their customers with yet another connector. He suggests licensing fees were at the centre of this decision. Apple in the past has collected royalties from the intellectual properties (IP) charges to external suppliers of Apple support devices. Figure 4 on the following page illustrates the quantity of iPhone models shipped from 2007 to 2017.

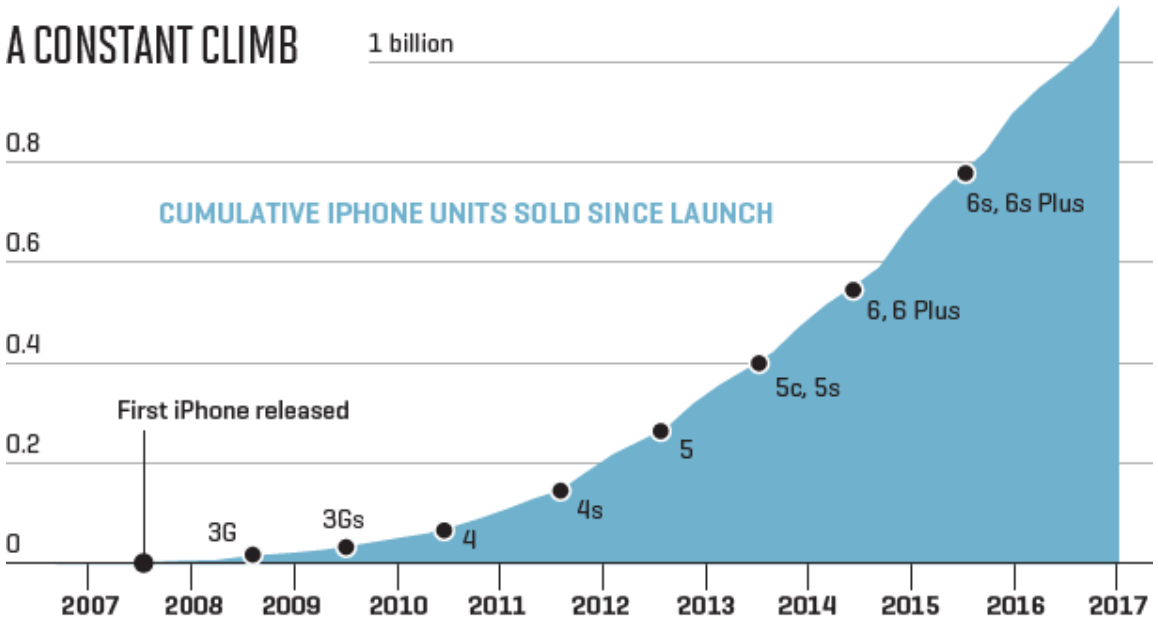

Figure 4: iPhone Market 2007 – 2017 (Source Nicolas Rapp Fortune)

2.9 Literature Synthesis, Gaps and Research Question and Hypotheses

2.9.1 Literature Synthesis Introduction

The literature review illustrated that various industries and product types rely on standards bodies and guidelines. The literature also highlighted the delicate and complex issue of competitor interactions and partnerships. The purpose of the literature synthesis is to provide a logical summation of the literature review, the contribution to the research and highlighting the identified gaps from the literature. These findings assisted in the development of the research hypotheses and questions which this current research addresses.

2.9.2 Literature Synthesis

Standards Environment: Even though there are elements of concern with normally competing companies engaging in standardisation and co-opetitive behaviour the literature supports that formal standard-based alliances can address large markets and provide the consumer with a greater confidence that can have a positive effect on the product adoption. Belonging to a standards-based alliance, and being involved in standards development with direct competitors, is often a different approach for member companies and some internal and external changes may be required (Nasir and

Altinbasak, 2009). Single company venture trade-offs must be seriously considered by management before joining forces for market adoption. There are many different motivations for entering into a co-opetitive situation.

Theoretical Underpinnings: The theoretical economic underpinning to understanding behaviour within a standard setting alliances generally stems from traditional game theoretical approaches, and in particular Nash equilibrium. In addition, the economic theory of clubs can provide a general understanding of how a standard setting alliance might evolve over time, whether it might be a homogenous or diversified club depending on scale economy issues, and the how the behaviours of firms might change as 'congestion' or crowding starts to appear.

Alternatives to Standards: The literature review found examples of companies not utilising standards organisations but instead opting to go it alone. On both occasions, granted, these were very large companies (Sony and Apple Computers). Market influences on consumer demand can make a product or service successful; however, one tried and tested methodology of product introduction is through industry standards-based alliances.

Structure of Standard-Based Alliances: The literature reviewed categories and detailed the differences and restrictions between informal and formally structured organisations. Informal competitive alliances were identified as much riskier and least preferred by the current generation of organisations. Government involvement was uncovered as an element that should be given consideration depending of the market and reach of the standards alliance.

Technology Standards: The literature review highlighted that Information Technology (IT) appears to be an industry that drives a tremendous amount of standards-based activity, possibly in part due to the huge costs involved and the amount of innovation and R&D investment needed. This particular industry was the most prolific application sector, which generated a high amount of literature. Companies producing advanced technologies are no strangers to utilising standards-based alliances.

Wireless Power: Literature for both Wireless Power technologies of induction and resonance was available, although limited. This restriction extended to the details of the three standards organisations, the Wireless Power Consortium, Power Matters Alliance

(both induction) and the A4WP, which is described as the leader in magnetic resonance introduction. This limitation provides the current research with an opportunity to contribute to the small pool of material on the subject matter and organisation.

2.9.3 Literature Synthesis: Gaps

The literature referenced in the current research ranged between multiple industries, geographies and technologies, and gave a solid commentary on the previous questions surrounding standardisation and its implementation. However, in spite of the large and constantly increasing literature and body of research on standardisation, several gaps in our knowledge still remain.

Lack of empirical studies at the alliance level: Most of the empirical research that investigates standard setting is at the marketplace level, and not at the alliance level. In addition, the vast majority of empirical studies that examine alliances tend to be broad cross-sectional studies across a variety of alliances in different technologies using very general publicly available data. Thus, these studies tend to be not very deep in terms of both data analysis and interpretation. In addition, pooling data from very different alliances can create analytical and model estimation problems. More complex issues such as member power development, IP development, and social network relationships are often missed in these cross-sectional/technology studies.

Few empirical studies of the internal workings of standard-setting alliances: Few in-depth empirical studies exist that are able to obtain data from alliance minutes, attendance and voting records that allow for an analysis of the internal workings of alliances and how firms develop influence. In addition, the empirical studies that have been published all use data from the same alliances where the data has been made publicly available.

Interview/qualitative details: There are very few published articles that include direct interview material about the subject matter, particularly in conjunction with a quantitative analysis. The current research was able to include interviews; however, there appears to be a gap in the current literature of face-to-face interview results. This addition would assist in balancing the quantitative research that appears dominant.

Wireless power specific literature: Even though the technology was developed in the ninetieth century, there is little published research on the adoption and applications of

wireless power technology. The IHS Wireless Power 2015 report (Figure 1) predicts consumer products with embedded wireless power will increase in popularity and gain widespread market adoption. This increase in awareness may result in future published literature. This current research would in part address the lack of academic material on wireless power.

Material on time/length of time to market for standards: Even though literature exists on various standards bodies, there is a gap in understanding the amount of time it takes to develop a standard. The existing materials study specific standards groups in developing their structures, but an identified gap understands the typical time spent on the endeavour. The literature lacks a holistic account of standards activity detailing investment in terms of time and resources.

Intellectual property position: The subject of IP positioning with technology standards appeared throughout the available literature, however IP payment was identified as an important gap. The IP that members attempt to include in technical standards also requires a licence and an agreed amount of payment. A gap exists in research covering IP volume payments and amount of license agreements achieved through standards-based alliances.

The influence and power of members: Although the existing literature on standard-setting through alliances includes discussions of several characteristics, there remains a gap in the literature regarding measuring the value and influence that individual member companies have within an alliance, and how they directly and indirectly influence the decisions of an alliance.

Revenue achieved from successful positioning within standards orgs: Once a standard is set and agreed upon, there is little literature on commercial success following the period of implementation. Setting and adopting a standard may not always prove financially successful for all members. There is an identified gap in the current literature on calculating the commercial impact of a standards body.

Alternative to standards: There are examples of companies going it alone and not joining standards-based alliances, but they are limited to a few very large organisations. A need exists to identify examples of alternative strategies used by companies that choose not to enter into a standards agreement.

Replication studies: While there exist a few in-depth studies of specific standard setting alliances (such as Bar and Leiponen, 2014 and Dokko and Rosenkopf, 2010), there remains a need to replicate and/or specifically build upon these studies in order to confirm and expand the findings and models suggested in these more in-depth studies. Replication studies with different technologies can provide better insight into the external validity to the findings.

2.9.4 Literature Synthesis: Research Questions and Hypotheses

Addressing the specific gaps in the literature, and working with the baseline study of Bar and Leiponen (2014), led to the research questions and hypotheses below within the context of data gathered from the A4WP membership. The research questions were specifically designed to investigate if companies leverage their position in standards groups.

The key two broad research questions in this current research are:

1) What strategies are developed by member companies seeking to position themselves into positions of influence?
2) Do large companies have an advantage due to size and available resources over the smaller member companies who may not be able to support contributing equally to the standard setting process?

The current research builds upon the Bar and Leiponen (2014) study with a new, highly relevant sample, and then significantly extends their model of the standard setting A4WP alliance within the wireless power industry. The first three hypotheses address the impact of IP, alliance centrality and company size represent the 'baseline' for the present study. The baseline hypotheses are:

H1: *A firm's intellectual property (IP) portfolios (patent stock) are positively related to standard-setting influence.*

H2: *Centrality in the alliance network is positively related to standard-setting influence*

H3: *Company size is positively related to standard-setting influence.*

The data acquired for this research from the A4WP community included additional member data points which allowed the current research to greatly expand the number of independent variables used in regression, and thus address additional issues and

relationships. Data also included the activity performed by each of the seven committees, year member firm joined and committee leadership positions. Also, centrality data in the present study was measured similar to Dokko and Rosenkopf (2010). This additional data allows for examining several new variables, and their impact. The following additional hypotheses are therefore offered:

H4: *Network Betweenness in the alliance network is positively related to standard-setting influence.* This hypothesis suggests that the greater the total amount of connection points that an individual member company achieves with other members increases the influence on the standards body (Freeman's Betweenness).

H5: *Alliance tenure is positively related to standard-setting influence*. The hypotheses concerns whether the earlier a member firm joins assists in the gaining of influence within the standards organisation, or is the time of joining not important to the member's ability in gaining a position of influence.

H6: *Committee 'chairmanship' is positively related to standard-setting in influence.* This allows the testing of positions of perceived power within the seven committees to see if there is actual control from the chair (leadership) position.

H7: *Technical committee membership is positively related to standard-setting in influence*. The activity performed by different committees has different effects on the influence leveraged by each active member. By 2014, the A4WP data had seven committees (one being the Board of Directors). Key committees are believed to be technical in nature. Two technical committees were in existence during the full period of the A4WP, the Certification committee and the Regulation committee.

Finally, the current research was able to interview various members of the alliance about the standard setting process. While this data is not specifically used to examine the seven specific hypotheses presented above, it allows for a discussion of the important nuances of standard setting, and expands the findings from the quantitative models.

The qualitative interview section enabled the following discussion points to be captured:

- Which of the seven committees is the most important within the A4WP?

- What are the member's company's strategic behaviours with respect to being involved in a standard-setting consortium?
- Which companies propose and vote for work items?
- Which member application category is the most influential within the A4WP?
- Which member company is the most influential within the A4WP?
- What are the risks of dealing with competitors?
- How connected each member is to other members?
- The next chapter describes the research methodology, including details of the data collected, methods used, pilot study and analysis.

3. Chapter Three: Research Methodology

3.1 Introduction

The subject of the research is focused on investigating the value of formal alliances and competitor interdependency within a technology standard setting alliance. This research methodology chapter discusses the methods used in both the pilot study and the full data collection process, including access to material, member activity monitoring and company positioning, and the methods used to analyse this information.

The in-depth analysis and information gathered in the previous literature review chapter led to the development of the two broad research questions:

1) What strategies are developed by member companies seeking to position themselves into positions of influence?
2) Do large companies have an advantage due to size and available resources over the smaller member companies who may not be able to support contributing equally to the standard setting process?

The current research expands upon the baseline work of Bar and Leiponen (2014) and Dokko and Rosenkopf (2010) who examined how member companies leverage their inter-alliance contacts with a standard setting alliance. Seven hypotheses were developed to explore these research questions.

3.2 Research Design and Methodology

The current research first examines three baseline hypotheses that stems from the results of these prior empirical studies of influence in standard setting organizations. Four additional hypotheses are then examined. The current research also includes structured face-to-face interviews of wireless power executives. This element of face-to-face interviews adds a valuable aspect to this research (Baker and Edwards, 2012).

The literature review highlighted the opportunity to add to the existing body of research on standard setting by being able to have direct access to an alliance membership and conduct qualitative research. There are a number of arguments regarding the merits and differences between the two methodological philosophies of positivism and phenomenology (Elliott, 2005).

Positivist: High volume data can be productively and effectively analysed. The method based on positivism (Balnaves and Caputi, 2001; Muijs, 2004) used in the current research relied on statistical data analysis. This is achieved from membership category data, and details of the structure of the 7 committees.

Phenomenological: This favors how the researcher can observe and understand the interaction (Hollway and Jefferson, 2000; Fischer, 2006; Hennink et al., 2011). Transcription material from 20 executive interviews and the collection of the committee minutes enabled this phenomenological element to be used in this current research.

Access to individual executives engaged in the A4WP and membership data permitted both philosophical approaches to be included in the current research. The decision to combine both normally separate methods of 'positivism' and 'phenomenology' was taken as they each method provide merits individually allowing analyses of both the vast amount of statistical member information and the member interactions. The quality and significance of the current research by applying both methods produced some key insights and added value to the thesis, which increases the material's contribution to the received literature on standard setting alliances.

There have been only a few recent large-scale empirical studies within an actual standard setting environment. As previously discussed, the Bar and Leiponen (2014) study represents an important baseline for the examination of technology standard setting and alliances, and this current research is designed to expand on this study in several ways. The table 2 on below compares and contrasts the empirical research of Bar and Leiponen (2014) and the current research.

Table 2: Comparison Table of Bar and Leiponen (2014) and the Current Research Study

Bar and Leiponen, 2014	Robertson 2019 (similarities)	Robertson 2019 (differences)
Industry: Wireless Telecommunications 3G standards body - Third Generation Partnership Project (3GPP)	Industry: Wireless Power standards body - The Alliance for Wireless Power (A4WP)	Industry access to research topic/standards organisation (A4WP)
44 international companies	137 international member companies	Access to all members
64 temporary committees	7 permanent committees	Access or involvement to all committees

14 meetings over 4 years (2000-2003)	Three years of bi-weekly, monthly meetings activity (2012-2014)	Three years of bi-weekly, monthly meetings data
IP patent's held	IP patent's held/Component IP member category	IP is included in one member category for both company and committee interactions and attendance
Social network connections – measured though ad-hoc primary, secondary, and tertiary	Social network connections, measured same as Bar and Leiponen	Social network connections measured as Freeman's Degree Centrality using formal social network analysis (SNA)
Regression Analysis: studied member activity primary direct/indirect connections, technical, size, etc.	Regression Analysis: study member activity based on connections, technical, size, etc.	Able to analyze committee structures for primary, secondary and tertiary contacts
No actual or direct measure of influence, influence is implied		Actual measure of influence, actual technology standard proposal introduced for consideration
No Primary Research or face-to-face Interviews		Primary research (20 face-to-face interviews). Asked questions of members regarding membership risks/fears of having competitors in the same organisation, strategies, and expected outcomes

The current research follows a similar methodological approach as prior empirical studies of standard setting organizations by gathering the following information,

- Member's profiles: name, revenue size, month/year joined, intellectual property, etc.
- Identification of 50 active members: the names of all 'supporters' who interact directly within a committee (membership data May 2012 to October 2014).
- Identification of 87 non-active members: the names of all 'sources' that don't interact actively within committees (membership data May 2012 to October 2014).
- All committee minutes and meeting attendees, covering activities of seven committees over three years (membership data collected covers 2012, 2013 and 2014).
- Contact details: Collected all intercompany primary, secondary and tertiary contacts interaction points.

- Other data: Collected all presentations, standards proposed, member resignations and election results.

3.3 The Sample

The A4WP alliance is focused on the adoption of wireless power in consumer devices such as smartphones, tablets and personal computers (Waffenschmidt, 2011). Official approval to access data and to speak to the individual members of the A4WP was granted for this research (Appendix B). Figure 5 shows the A4WP member logos as of October 23, 2014, the membership count was 137 fee-paying companies and seven working committees. Membership data included member company names, revenue size, membership level and length of membership etc.

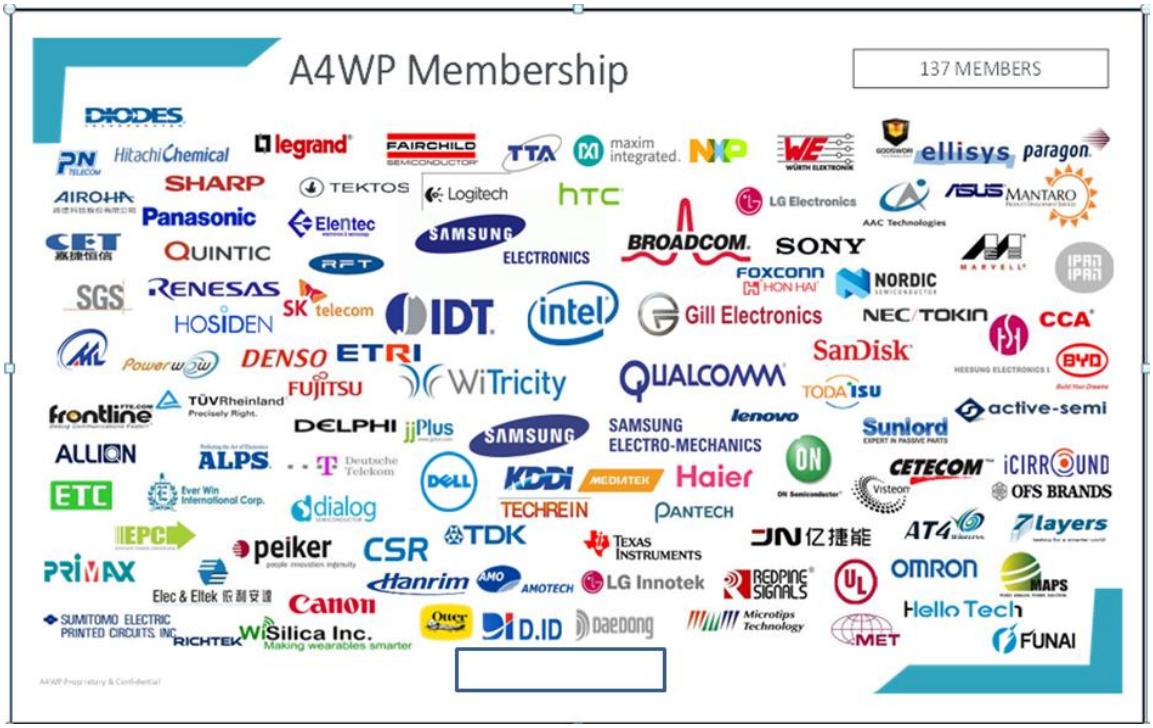

Figure 5: A4WP Membership Overview (Source A4WP)

3.3.1 A4WP Committees

The A4WP as of October 2014 had seven formal working committees, including the Board of Directors. The seven working committees were formed from the 137 members but only 50 of these member companies were actively involved in these committees. Bar and Leiponen (2014) named the active committee members as 'supporters' and non-committee member companies as 'sources'. Using the nomenclature of Bar and Leiponen (2014), the A4WP has 50 'supporters' and 87

'source' member companies. The data from the 50 active contributing members of committees was analysed for 'Primary Contacts', as gauged by the level of interaction points each company has made. A primary contact is made with fellow members of each committee; a company can have multiple primary contacts with the same company if they are active on more than one committee.

Each of the seven A4WP committee members is detailed below, figures 8.2-8.8 (diagrams produced by the NetDraw program). Primary contacts are achieved by members of the same committee.

The Committee Names and Names of Member Companies as 'Primary' contacts as of 2014 are listed and described below.

1. Board of Directors:
2. Test/Certification Committee
3. Regulatory Committee
4. Marketing Committee
5. Technical <5W Committee
6. Technical >5W Committee
7. Resonator Committee

Committee One, Board of Directors (2014): The BoD contains eight supporter members; only three were founder members. The A4WP board members pay exactly the same joining and annual fees, which allows for equal voting rights. The Board President is from Qualcomm (blue) and the Vice President is from Samsung; these are elected positions.

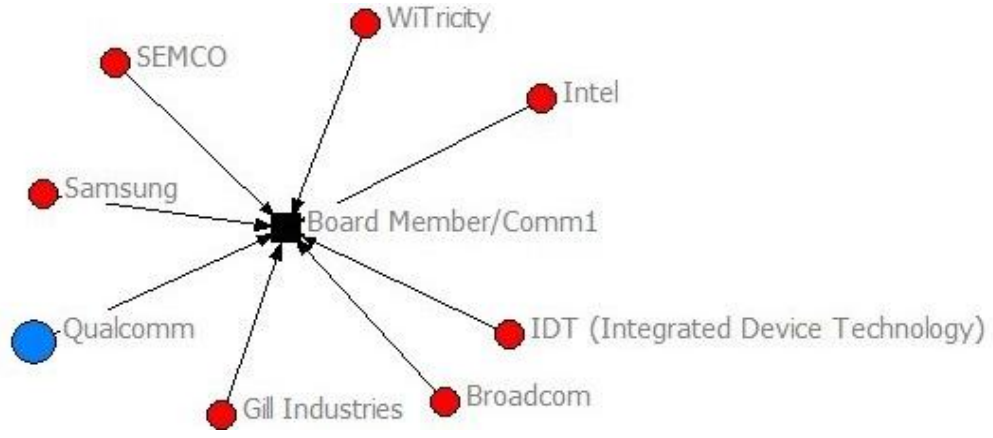

Figure 6: Board Committee One

Committee Two, Test/Certification (2014): This group is charged with approving a member's products by performing the necessary technical tests to insure its compliance to the standards specification. Once the technical specification has been successfully tested, this organisation awards the consumer compliance certificate, which is attached to the product. The committee has 24 primary contacts; the member's fee is based on size and type. The committee chair is from Qualcomm (blue) and is an elected position.

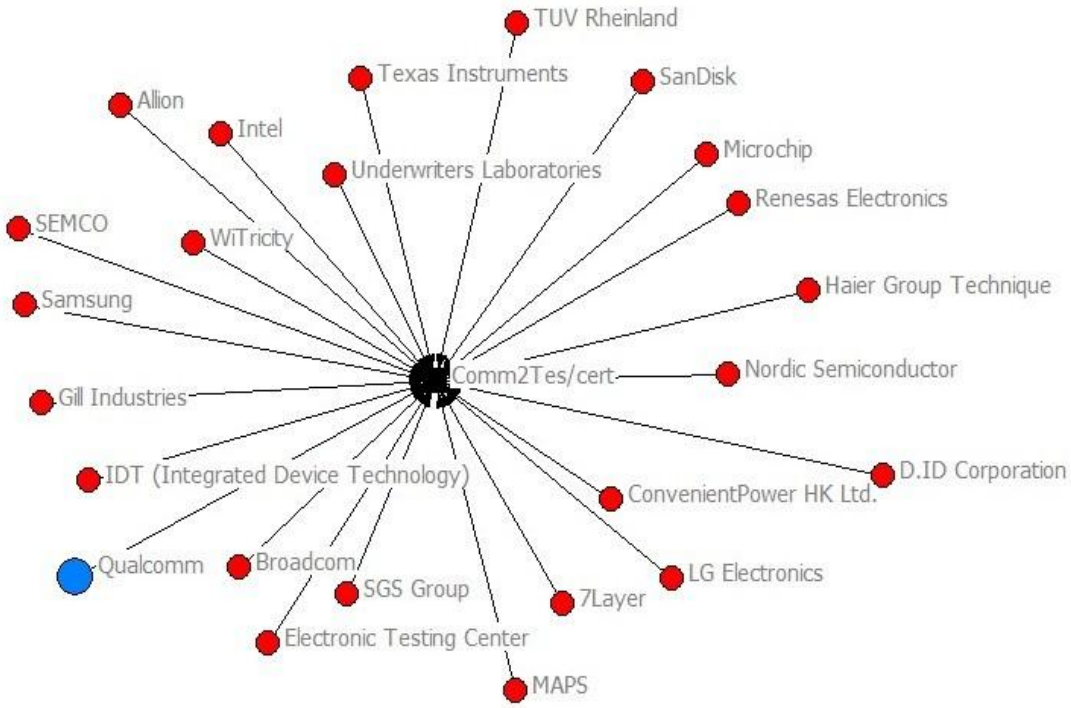

Figure 7: Test/Certification Committee Two

Committee Three, Regulatory (2014): This group is responsible for achieving the necessary government, safety, country and regulatory body approvals of the A4WP standards specifications. The committee has 27 primary contacts, and the member's fee is based on size and type. The committee chair is from Intel (blue) and is an elected position. Figure 8 on the next page illustrates committee three's connections.

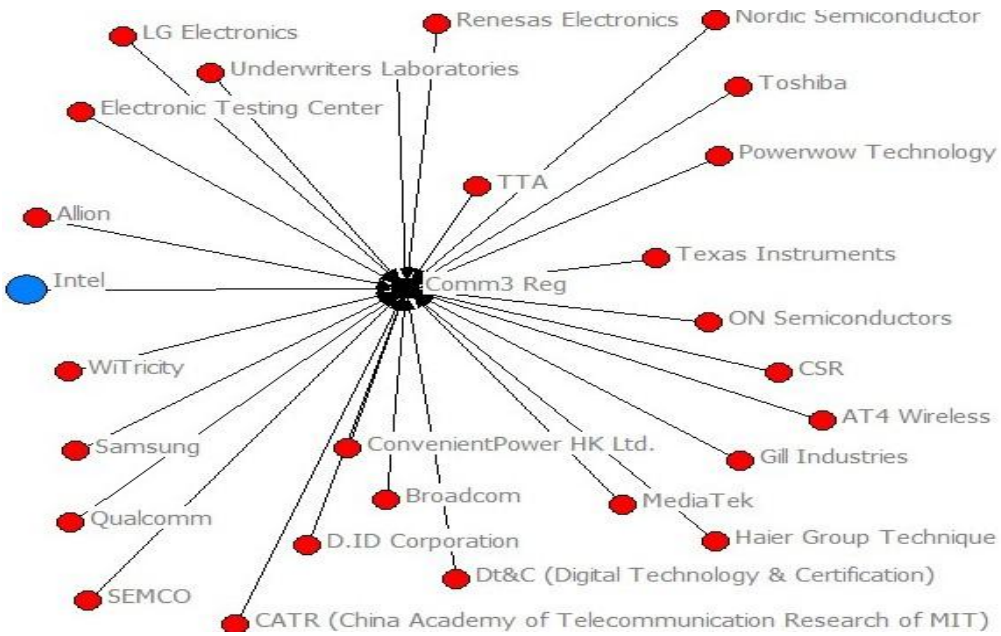

Figure 8: Regulatory/Compliance Committee Three

Committee Four, Marketing (2014): This group provides the marketing material for members to use in promoting their products, and this group also is charged with promoting the A4WP brand as the premier wireless power standard. The committee has 31 primary contacts, and the member's fee is based on size and type. The committee chair is from Qualcomm (blue) and is an elected position.

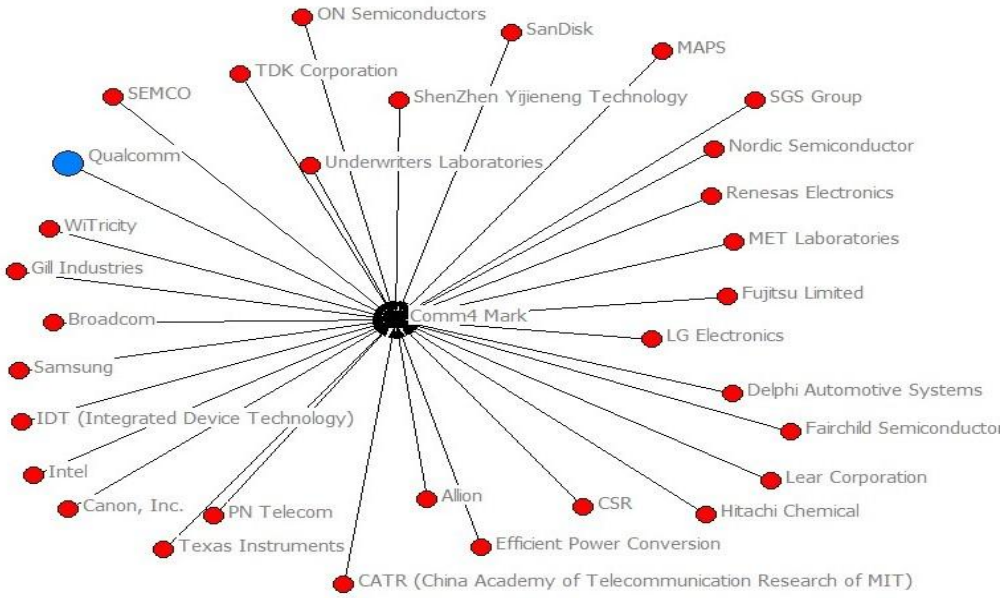

Figure 9: Marketing Committee Four

Committee Five, Technical One <5W (2014): This group is charged with developing the technical specification for low powered devices. Low power consumer devices are typically products that require 5 watts of power or below. The committee has 36 primary contacts, and the member's fee is based on size and type. The committee chair is from Samsung (blue) and is an elected position.

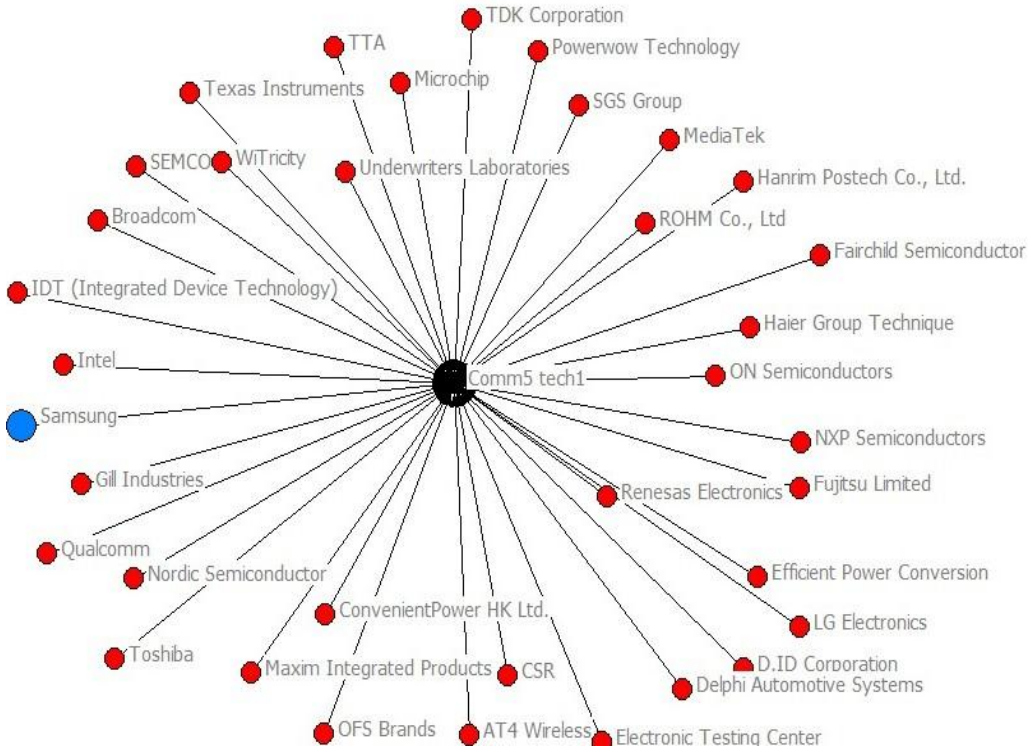

Figure 10: Technical One <5W Committee Five

Committee Six, Technical Two >5W (2014): This group is charged with developing the technical specification for high powered devices. High power categorisation is typically given to products that require greater than 5 watts of power. The committee has 26 primary contacts, and the member's fee is based on size and type. The committee chair is from Intel (blue) and is an elected position. Figure 11 on the next page illustrates committee six's connections.

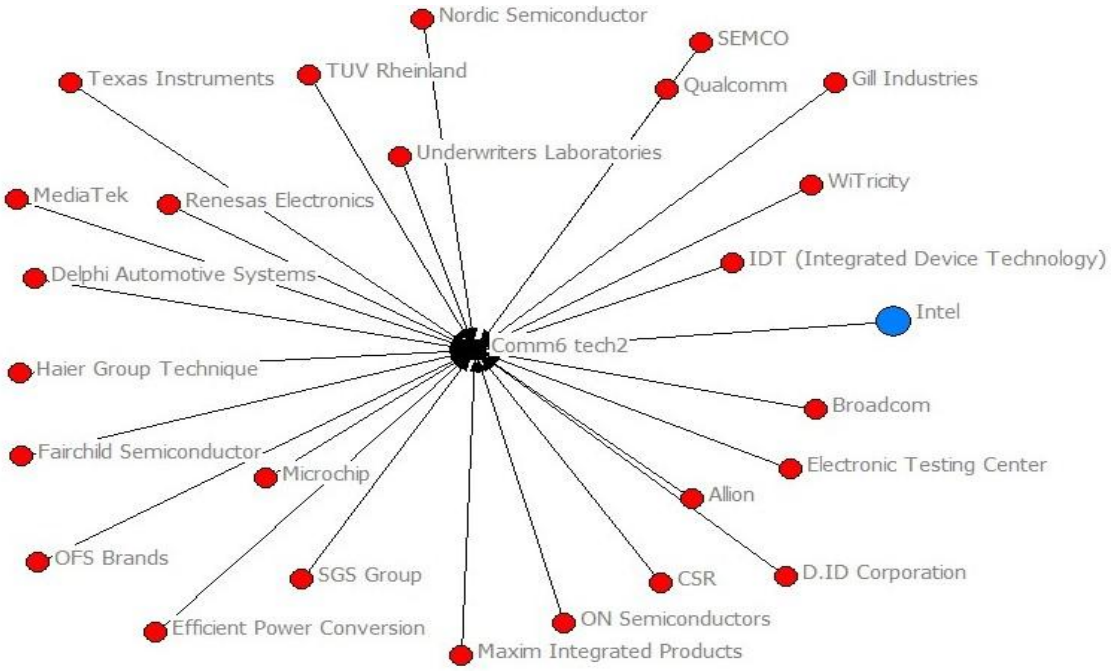

Figure 11: Technical Committee Two >5W Committee Six

Committee Seven, Resonator (2014): This group is charged with developing the technical specification for the resonator technology which was identified as a key necessary technology needed for wireless power transfer. The committee has 18 primary contacts, and the member's fee is based on size and type. The committee chair is from Wi-Tricity (blue) and is an elected position.

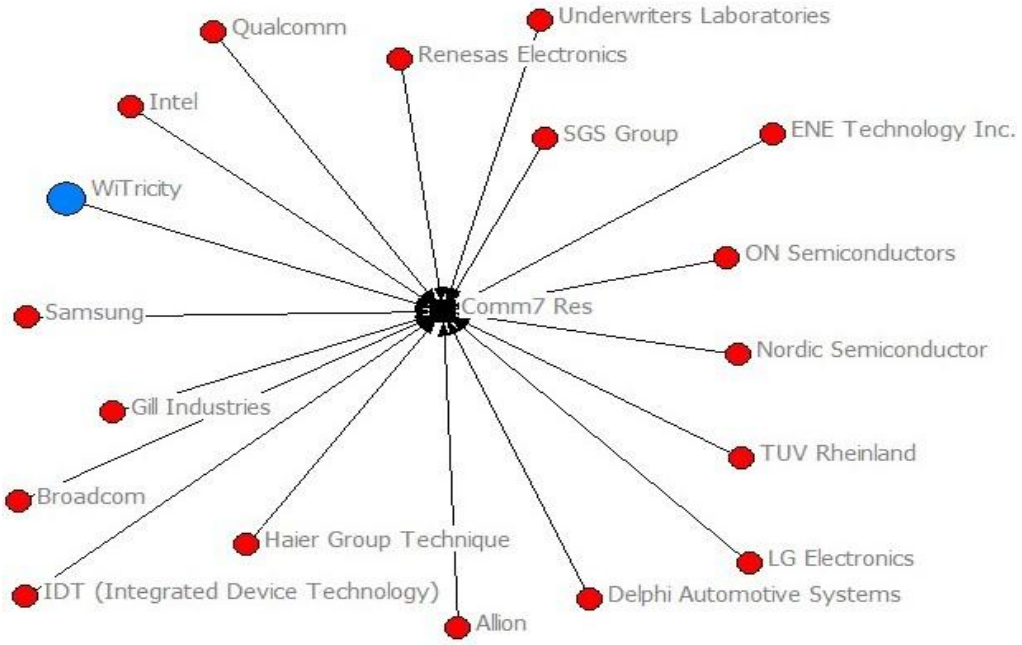

Figure 12: Resonator Committee Seven

3.4 Quantitative Methods

3.4.1 Dependent Variable Used in the Quantitative Analysis

The dependent variable used in the research represents a direct measure of alliance influence.

Influence (Proposal Percentage): The focus of the present research is to examine influence in the technology standard setting process. In particular, the dependent variable is measured by the percentage of standard setting proposals introduced per year by a particular active member firm. This was determined from an examination of each of the working committee meeting minutes for each of the years (2012 to 2014). Unlike prior studies, standard setting proposals is a direct measure of influence since before proposals are formally introduced to a committee by a committee member, there generally is background discussion analysis and agreement by other committee members. Since the number of committees increased per year, and the number of proposals varied per year, I used the percentage of the total proposals per year that are introduced by a particular member firm to control of this variance. This measure normalizes the data between years.

3.4.2 Independent/Predictor Variables Used in Quantitative Analysis

The independent or predictor variables used in the quantitative analysis are similar to those used by Dokko and Rosenkopf (2010) and Bar and Leiponen (2014). In addition, several new variables were examined. Table 3 on the next page summarises the independent or explanatory variables used in the quantitative section of the research. The independent variables for the full model include: intellectual property portfolio, tenure (how long a member in the alliance), revenue size, committee chair, committee membership type (Test/Certification and Regulation), Euclidean technological distance to source, as well as the various measures of alliance network connections, such as primary, secondary and tertiary connections as well as two measures of Freeman's centrality measure - 'Betweenness' and 'Degree'.

Table 3: Measures and Variables: Quantitative Analysis (Source A4WP)

Independent Variables	Details
Tenure	Time a company has been a member of the A4WP represented as a percentage of the total time since the A4WP was established up to the point when the company joined.
Revenue	Three Categories: <$5M, >$5M<$50M and >$50M (US Dollars). Coded as 1, 2, or 3.
Committee Chair	Number of committee chairs held by a particular company, range between 0 and 3.
Committee Type	Membership in the seven working committees.
Patent Portfolio	Count of wireless power patents by member firms. This is based upon a search of the USPTO.gov website. The search was based upon the key words of wireless power.
IP Euclidean Distance (Intellectual Property)	The Euclidean technology measure examines the share of IP owned by firms in the various industry categories as a distance metric.
Primary Contact	Number of direct contacts in committees (A company can have more than one primary contact is they appear in two or more committees.
Secondary Contact	Number of Contacts from same member type category.
Tertiary Contact	Number of contacts that have no committee or member type relationship.
Freeman's Betweenness Centrality	Freeman Betweenness Centrality measures a member's position within the path of interactions between other members. Measure calculated by UCINET.
Freeman's Degree Centrality	Freeman Degree Centrality measures the amount of connections between members. Measure calculated by UCINET

The following provides details of the independent variables used in the regressions

Primary, Secondary, and Tertiary Connections: Following Bar and Leiponen (2014) All members of the A4WP were categorized as having three levels of connections, 1) Primary contact: gained by two companies being the members of the same committee, 2) Secondary contact: gained by being members of the A4WP within same membership or application category, and 3) Tertiary contact: this is gained upon becoming a member of the A4WP.

Freeman's Degree Centrality and Freeman's Betweenness: Connections were also measured by two centrality variables: Freeman Degree Centrality and Freeman's Betweenness Centrality. Network centrality is often considered a measure of 'power' or 'influence' within a network. Freemans Degree centrality is used as a measure of connections the firms had within the alliance similar to the Dokko and Rosenkopf (2010) study of the Telecommunication Industry Association standard setting committees. In essence, the A4WP alliance can be considered a network of member firms. Being a member in a working committee creates direct connections with other committee members. Committee members, however, on one working committee may also be members of other committees thus creating secondary connections. Freeman's Degree Centrality measures direct connections, adjusted by overall network connections. Membership in a committee is non-directional. Freeman's Degree Centrality was calculated from the UCINET program, with input being an NxN matrix, where the cell entries represent the number of direct connections a firm has with all the other (N-1) firms based upon committee membership. Given a total of seven committees in 2014, the maximum cell entry between two firms in the matrix would be 7 for 2014. This analysis was also done for 2012 and 2013, with the maximum number of connections for these years represented by the total number of committees existing for that year.

Whereas Degree Centrality represents the number of connections of a particular node, the Freeman's Betweenness Centrality metric quantifies the number of connecting 'nodes' or members each company has. In essence, Betweenness measures how much a node within a network is used to join other nodes within the network via the shortest path.

USPTO Patent Portfolio: IP **(**Intellectual Property). Count of wireless power patents by member firms. This is based upon a search of the USPTO.gov website. The search was based upon the key words of wireless power.

Euclidean Technological Distance: This independent variable is the calculation of the amount of assigned patents each member has in the named technology applications as per the records of the United States Patent Office (USPTO). The A4WP membership is categorised into seven applications. The technical distance to source was recreated as per Bar and Leiponen (2014) by calculating the Euclidean distance from source. The

Euclidean distance between firms is one measurement of technology connections: "it compares for each technology category the squared difference of the share that technology category has in firm *i* and the share that technology class has in firm *j*" (Stellner, 2014, p.10). Searches of the United States patent and trademark site (USPTO.gov) produced a total of 1615 named patents from all 137 members in the 7 applications of Auto, Carrier, Consumer, Design and Test, Furniture, Non-commercial and Component. Data analysis created a 7-dimensional vector for each member (Bar and Leiponen produced 15-dimension applications). The source vector was calculated in a similar manner such that for each of the 7 categories the percentage of patents in that category. The author calculated the Euclidean distance between the source vector and the corresponding vector for each member (larger the distance from the source the less the member is connected) $Distance_i = sqrt(\sum(S - V_i)^2)$ where S is the source vector and V_i is the vector for each company.

Revenue Size: Member company size was chosen as an independent variable to test if larger companies with greater human and financial resources have an advantage over smaller member companies. The A4WP members are divided into three stated revenue size categories according to the membership documents, and this data was analysed in three categories of revenue size: 1: <$5M, 2: $5M<$50M, 3: >$50M.

Committee Type (Test/Certification and Regulation): The activity performed by each of the seven committee is captured in the A4WP data and is included as an independent all the data was tested to identify which committees has the greatest influence. Membership in two committees, Test/Certification and Regulation are tested in the regression.

Tenure: The date each member joined the A4WP was obtained from the alliance records. Standards Alliance Tenure was calculated as the time a firm was a member of the alliance divided by the time the A4WP was in existence. High tenure means that a firm had been a member longer in the alliance.

Committee Chair: The seven working committees each have a member company who fulfil the annually elected position of Chair. This person represents the committee in all official reporting, execution of activity and presentations to the Board of Directors. This independent variable test if this activity provides the member with any advantages.

3.4.3 Regression Methodology

Because the sample data is over the three-year time-period with the number of members firms increasing each year, the data is considered an unbalanced panel. I therefore estimated two models, one model controlling for time effects (dummy variables for 2012 and 2013) and a Fixed Effects model on the data that had more than one year of tenure in the alliance. Fixed Effects regression is used when the impact of variables may change over time. Fixed Effects regression removes the time-related components in order to better determine the net impact of the predictor variable on the dependent variable; thus the regressions results in time-invariant intercepts for the estimated coefficients for each firm.

Because the dependent variable of influence is an active firm's percentage of standard proposals submitted per year, this represents a censored variable with numerical limits of '0' and '1'. If there is a clustering of data points at the censoring limit edges (such as '0' in the present data) then Ordinary Least Squares (OLS) regression will result in biased estimates. Therefore, for the regressions using the percentage of proposals per year as the dependent variable, I used a Tobit regression model censored at zero for the lower limit, and one for the upper limit. Tobit regression is a non-linear, Maximum Likelihood Estimator (MLE) specifically designed for censored dependent variables.

Regression models were estimated using the *LIMDEP* (version 11) statistical program developed by Econometric Software, Inc. The name, *LIMDEP* is derived from the term, *LIM*ited *DEP*endent variable model, and specifically designed for various conditions affecting the dependent variable in regressions and other statistical techniques. *LIMDEP* is also designed to handle unbalanced panel data, such as in the present research.

R^2s are often reported in OLS regression. However, R^2s are not applicable for non-linear regression techniques, such has Tobit. A number of pseudo-R^2s have been suggested for Tobit regression. For the general Tobit regression, the present study reports the Decomposition Fit measure. The Decomposition Fit measure is a pseudo-R^2 calculated as the variance of the conditional mean function around the overall mean of the data in the numerator (Greene, 2002), and is similar to R^2 in OLS but should not be compared directly with an R^2. The Likelihood Ratio Chi-square statistic is also reported, and measures overall model significance.

When analysing the full panel data, 2012 to 2014, Tobit regressions are estimated two ways, controlling for time differences (dummy variables for time) and a Fixed Effects model control for firm variation over time. A sub-sample of just active members (firms that are members of one or more of the working committees) from 2012 to 2014 is also analysed. As with the full sample, this 'active' subsample also represents an unbalanced panel data. For the analysis of the 'active' sub-sample, the two Tobit regression models described above are again estimated. In addition, since the dependent variable measurement for 'active' members are more broadly distributed throughout the censored range (between 0 and 1), two OLS regressions (controlling for time and Fixed Effects) are also estimated and compared with the Tobit regressions.

In the present research two 'baseline' models are estimated. These baseline models examine the first three hypotheses and is similar to the Bar and Leiponen (2014) model. The first baseline model uses the variables of 'primary, secondary, and tertiary' connections as defined by Bar and Leiponen (2014). These variables represent connections within the standard setting alliance network. In the second baseline model, 'primary, secondary, and tertiary' connections are replaced by Freeman's Degree Centrality. Freeman's Degree Centrality directly measures the centrality of connections within the standard setting alliance network, and is the same measure of centrality used by Dokko and Rosenkopf (2010).

The remaining four hypotheses are then examined by estimating a full-model with the appropriate independent or predictor variables added to the model as a block.

Figure 13 on the next page illustrates how the regression model related to the seven hypotheses developed in Chapter 2.

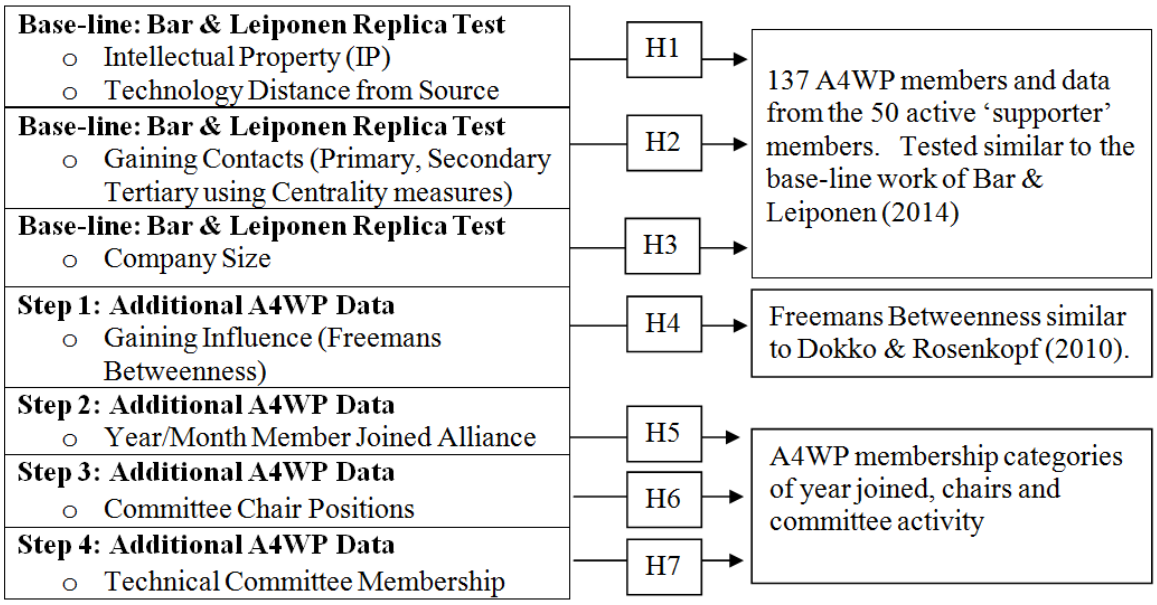

Figure 13: Regression Steps

3.5 Quantitative Methods

The research also allowed the use of a phenomenological paradigm using a qualitative method of data collection. The qualitative study was carried out with a selection of executives in a face-to-face interview format (Mann, 2011).

This qualitative methodology required a dialogue with the individual company executives to discuss their experience of standards and co-operative/competitive relationships. Using this method, a standard set of questions was selected to gather qualitative commentary. The interviews were achieved from the executives who attended the events between December 2013 and March 2014 and responded positively to a request for a scheduled meeting time. This time period for the interviews is important since by early 2014 the full 7-committee structure of the alliance was in place. The interviews were recorded and transcribed for review and reference.

As most of these interviews were within the USA and target USA citizens (18 out of 20), the author expanded his USA interview knowledge of correct interview procedures and ethics by studying human ethics with the Collaborative Institutional Training Initiative (CITI), the most recognized certification agency for administering Human Subject testing in the USA. Completing the Social/Behavioural course (using the module designed for social science research) provided the author with additional knowledge on ethical concerns, confidentiality, conflicts of interest and consent

methodology and papers (Hicks, 2011, Robinson Baily, 2014). Appendix D is the CITI completion report and details of the courses studied.

3.5.1 Pilot Scheme

Prior to the face-to-face interviews being executed, a pilot study was undertaken. Five pilot interviews were completed in December 2013 at the Austin, Texas, USA Wireless Power Summit event and one completed in January 2014 at the Las Vegas, Nevada, USA Consumer Electronics Show. The A4WP had requested member attendance at the Austin event to support the organisation. The five individuals interviewed attended the event and accepted the invitation for a meeting; one additional pilot interview was re-arranged for CES Las Vegas due to scheduling issues. All pilot interviewees agreed to be interviewed and agreed to be recorded. Their personal identity is not disclosed, only their business title and company name. A confidentiality statement was read prior to the start of the interviews and each pilot had to acknowledge their consent on the audio recording.

During the pilot test both the structure of the face-to-face interview format and the questionnaire were reviewed. Following this pilot some minor final amendments were made prior to confirming the discussion point for the planned interviews (Baker and Edwards, 2012). The executives in the pilot study of qualitative interviews aided the author to make the necessary amendments to the post-pilot interview questions. Due to some overlap of information gathered in the interviews the author decided not to use the questionnaire format following the pilot test.

3.5.2 Pilot Scheme Outcome and Conclusions

The pilot study concentrated around ten key questions (Table 4).

Table 4: Pilot Interview Questions

	Pilot Questions Asked (Face-to-face interviews)	**Intention of Question**
1	Why is your company a member?	Probing Motivation of membership and reasons for joining with competitors.
2	Did your company consider developing technology without consortia membership?	Probing decision making process of co-opetition as a strategy.

3	Desired outcome of membership?	Desire personally may differ from the companies stated goals i.e. Personal growth and contacts against companies market penetration goal.
4	What are the perceived risks of membership?	Probing knowledge level of risk and attempting to draw if a process exists.
5	Value of membership to your product?	Strategic value metric.
6	Innovation advantage/IP sharing?	Probing companies IP strategy with A4WP standards and understanding if they benefit from leverage their own IP or access to others IP.
7	Ecosystem dependency and reliance of competitor activity?	Probing if membership is to access customers or needing competitors to join and create the ecosystem.
8	Fears /downside/risk of dealing with competitors?	Probe to understand level of thought/strategy in dealing with 'risk' and 'negative' impact of co-opetition.
9	What are your companies rules of engagement with competitors	Formal or informal rules or training for the situation.
10	How much time/commitment does membership take?	Gauging measurement of project size.

Following the pilot test and analysis of results it was clear that the structure of the questions, responses and behaviours were of the quality needed for this new research. The ten questions were captured by audio recording and demonstrated that these talking points were able to prompt the interviewee into an open and direct qualitative dialogue of the motivations and desires of standards membership. None of the test pilot participants indicated negative reactions to the questions.

The length of the pilot test did not exceed the allotted time (thirty minutes), and they were held in a private meeting area, individually face-to-face and not as a group.

3.5.3 Post Pilot Scheme Amendments to the Qualitative Questionnaire

The Based upon the results of the pilot study, the author added additional questions related to influence gathering and strategies. Table 5 shows the additional six questions that were included in the March 2014 full interview meetings. The addition of these connection/interaction questions together with the 'which is the most influential committee' was designed to address the research questions and add an extra qualitative

value to current published literature of earlier work, and could increase the value of this new research.

Table 5: Post Pilot Interview Questions

	New questions (Face-to-face interviews)	**Reason for adding new questions**
1	Which type of company within the A4WP do you talk to the most?	SNA input data to show volume of interaction between member companies to show results of most active/least active, etc.
2	Who are in your opinion the most important members of the A4WP and why?	Bar and Leiponen (2014) offered the idea of power/importance between members. This question attempts to identify if this is true in the A4WP.
3	Are more members your customer or suppliers within the A4WP?	Probing question designed to give details of the ecosystem.
4	Has this changed over time?	Probing question about how the membership has doubled year over year as the ecosystem builds.
5	Which committees are you involved with and which committee is the most powerful and why?	Probing question designed to see link between their activity and the power/influence of their presence.
6	Who do your think is the member company able to make the A4WP standard successful? List three members...	Rating of power players within the alliance. Could show a clear/common set of names or could show a varied result.

The final interview activity in the research consisted of 20 face-to-face interviews (six pilot and fourteen full interviews) with key senior executives in the consumer technology industries and who were active members in the A4WP. The interviewees were chosen as they attended the four major events and provided access by their time availability. Many of the executives represented publicly-traded companies engaged in the wireless power industry. The size of the companies contacted was approximately one billion dollar (US) Market Capitalisation or above. All the companies examined are technology manufacturers or technology contributors with a proportion of sales revenue generated in the consumer electronics industry.

The interviews are used primarily for a thematic content analysis. Since thematic analyses methodologies of qualitative interviews are complex, sample sizes are typically small (see Crouch and Mckenzie, 2006). In fact, there are many published studies of thematic content analysis of qualitative interviews that use a sample less than 15. For example, in their thematic analysis of qualitative interviews, Galvin et al., (2015) used a sample of twelve, Molin et al., (2016) analysed a sample of eight interviews, and Wild et al., (2017) used only seven semi-structured interviews. The sample of twenty semi-structured interviews used in the present research is a typical sample size given the methodologies used in the qualitative component of the research.

Upon completion of the pilot test, the questionnaire survey format (categorical responses) was not used in the full study due to overlap of questions used in the face-to-face interviews. Rather the author focused on in-depth interviews to examine the nuances of standard setting rather than using a categorical response questionnaire format as in the pilot study.

3.5.4 Full Interview Sample: Changing Conditions for Interviews

Based Access to the members and material was limited to four face-to-face events held in multiple locations from December 2013 to March 2014. Both the pilot and full face-to-face interviews were completed at these opportunities, and the 20 individuals selected both attended in person and could schedule a meeting with the author at these events. The events drew attendance from a random sample base of highly active members and the interviews were arranged with these members whose companies permit business travel and who allocate time to support active member interaction and whose schedules enabled the meeting. The author's access to the membership database of categories, committees, fees, meeting notes and history was restricted to October 23rd 2014. This restriction to the member database was caused by changes in the A4WP organisation due to a proposed consolidation and changes in market forces. It was felt that interviews and data gathered after October, 2014 might be biased due to the merger discussions. No A4WP material has been gathered post this date.

3.5.5 Qualitative Content Analysis

This section covers the details of the 20 face-to-face interviews and the methods used to analyse the meeting transcripts. The interviews were recorded using MPEG-4 Audio software on an iPhone 5S, which enabled ease of use transcription, file sharing and data

mining. The interviews all followed the same script of questions and lasted between 15 and 25 minutes, the largest word doc file being approximately 4300 words. Due to the technology used and sound quality, the transcripts are a detailed replica of the voice file, with no embellishments or deletions.

3.5.6 Coding the Themes

A two-coder system was used to avoid bias and errors. The author was coder number one and selected the second coder from a contact in a previous MSc research thesis, this second coder was informed of each member's industry category, company type and each of the 20 interviewee's profession. During the analysis each coder recorded a '1' if the theme was present and a '0' if it was not included. Each coder analysed the material separately and noted their findings into a series of NxM matrices, where N=themes per question, and M=respondents.

Inter-coder agreement was further analysed using the Fuzzy Kappa modelling technique (Hagen-Anker, 2009). The Fuzzy Kappa statistic is used to measure inter-coder agreement in situations when a coder can identify more than one theme being present in an interviewee's responses per question. The standard Kappa statistics often used to measure inter-coder agreement should only be used for a single theme response per question, whereas the Fuzzy Kappa allows for multiple themes that a respondent might have identified per question (Hagen-Anker, 2009. The interviewee response for each question in the present study has a multi-theme characteristic, which actually approaches real life responses in many situations.

Using the 'Fuzzy Kappa' statistic, the inter-coder agreement was assessed using the categories often used for the Kappa statistics that is on a scale of 'poor', 'slight', 'fair' at the weaker (not preferred end of the scale) to 'moderate', 'substantial' to 'almost perfect' (the preferred measures of accuracy) levels of agreement. Some methods of two coding systems simply add both sets of codes then divide in half to produce the agreed amount but the "Fuzzy Kappa statistic expresses the mean agreement relative to the expected agreement" (Hagen-Zanker, 2009, p.61) which produces a clearer and accurate agreement measurement. The Fuzzy Kappa method was used to test the eight key questions that were also used for the Thematic Frequency Analysis described later. Fuzzy Kappa provides the results of number of times the two coders were in agreement in identifying each themes existence in the interview transcript, whereas the Thematic

Frequency table demonstrates the dominant theme per percentage of times mentioned in the interview. These two analyses provide a robust analysis of the two-coding system.

3.5.7 Co-Occurrence Thematic Analysis

One of the common problems in a thematic research is to determine the importance or priorities of different themes associated with a response (e.g., Guest and McLellan, 2003). To analyse the 20 face-to-face interview transcripts to understand the importance of the different sub-themes in relationship to each other, a co-occurrence analysis was performed on the thematic data. Following a process similar to Guest and Mclellan (2003), Myneni et al., (2013) and Choi and Kang (2014) and involves several steps.

First, an NxM matrix was developed for eight of the questions used in the face-to-face interviews. These eight questions were selected since they directly address the issues of motivation, perceived risk, and the overall strategy of being involved with the standard setting consortium. Identifying and processing these key items produces "the output from this procedure is an NxM matrix that shows the co-occurrence of topics" (Maurer et al., 2014, p.112). In this matrix, N=the number of sub-themes within each of the eight questions, and M=interviewees. In this matrix, when an interviewee identified a sub-theme as important, it was noted with a '1'. Since this research used two coders, a '1' was recorded if either, or both, of the coders recorded a '1'in their independent coding of the interview responses. Some interviewees may only mention one sub-theme during the interviews, while others mentioned multiple sub-themes as important.

Second, from the NxM matrix, a NxN 'co-occurrence matrix' was calculated. In the co-occurrence matrix the cell entries represent the number of times a particular sub-theme was mentioned in combination with other sub-themes.

Third, in order to visualize how the different sub-themes interact with each other, a diagram of the semantic relationships was developed using the UCINET NetDraw program for each of the eight interview questions (Choi and Kang, 2014). The semantic sub-theme relationship diagram shows the strength of the relationships between pairs of sub-themes and the direction of the relationship. The strength of the relationship between sub-theme pairs is indicated by the thickness of the line. A thick line indicates a high degree of co-occurrence between pairs of sub-themes. The semantic sub-theme

relationship diagram also shows the direction of the relationships. While not showing causality, an arrow pointing from one sub-theme to another them does indicate a form of 'dependency', or that a particular sub-theme is dependent upon the occurrence of another sub-theme.

The final step used in the co-occurrence analysis is estimating the importance of the different sub-themes in relationship to each other. In network analysis this is usually measured with a 'centrality' measure. While there are many measures of centrality, for the co-occurrence thematic analysis I use the 'eigenvector centrality' measure. Eigenvector centrality is a commonly used metric of importance within a network, and takes into account both direct and indirect relationships. It is also a non-directional measure of importance. To determine eigenvector centrality I used the UCINET program with the NxN co-occurrence matrix as the input matrix. Input to UCINET was accomplished by developing a matrix of member companies for each of the three years under examination, 2012 to 2014. A matrix was constructed for each of the committees, with a '1' entered for the bi-variate connections a company has with all the other companies within that particular committee, and a '0' of a company was not a member of that committee. Thus each committee matrix had a 1-0 matrix of connections between all the companies that where members of the A4WP for that year. For 2012 there were a total of 4 committees, for example.

The individual committee matrices where then merged into a master committee connection matrix. Thus, if there were 4 committees in a particular year (as in 2012), the maximum connection if a company was a member of all 4 committees with another company that was a member in all 4 committees would be a '4' with the merged master committee connection matrix. 2013 had 5 committees, so the maximum number of connections with another company in the merged 2013 master committee connection matrix would be '5'. 2014 had 7 committees, so the maximum number of connections with another company in the merged 2013 master committee connection matrix would be '7'. Each of these yearly master committee connection matrices were inputted into UCINET.

Examining all these forms of thematic analysis - the simple frequency count, the semantic sub-theme relationship diagram, and the eigenvector centrality of the sub-

themes - gives a much better picture of the importance of the different subthemes in relationship to each other within the interviews.

3.5.8 Cluster Analysis on Key Themes

A cluster analysis was also used to determine the existence of different strategic behaviors, or strategy archtypes, used with respect to joining and participating in the A4WP. Cluster analsys represents a set of methodologies that are designed to identfy groups (clusters) where the members of one cluster share similar characteristics among the input variables, but are disimilar from the members of another cluster. "Cluster analysis provides a useful alternative as it presents data in clearly defined clusters in two-dimensional space, rendering a quick and easy visual tool for interpretation" (Guest and McClellan, 2003, p.189).

The input variables from the scores of themes identified from questions 1, 4, 5 and 6 were used in the cluster analsysis. These four questions were used since they appeared most relevant to identifying an overall firm behaviors, including benefit and risks, associated with joining and participating in the consortium. Focusing on the most relevant four questions from the 'major eight' enable a clear set of input variables to be entered into the anaylsis software.

The next step of the cluster analysis is to select the clustering method. While there are many methods of cluster analysis which to choose, the selected method needs to conform to the objectives of the research (Clatworthy et al., 2005). This research used the SPSS version 21 cluster algorithm software for agglomerative hierarchical cluster analysis, and the squared-Euclidean metric to measure distance.

The Wards minimum variance method was used to determine clustering relationships. In the strategic management literature, the Ward's method of cluster analysis is the most commonly used method to determine strategy typologies or archetypes (Kethcen & Shook, 1996, p. 450). Szekely and Rizzo (2005) note that the, "Ward's method minimizes the increase in total within-cluster sum of squared errors. This increase is proportional to the squared Euclidean distance between cluster centres" (Szekely and Rizzo, 2005, p.152). Thus, the Ward's Method minimizes the total within-cluster variance. The Ward's method is a commonly used method when it is expected that

there are distinct clusters that may have similar size, and that there are few outliers in the data.

The input matrix to the cluster analysis was a '2', if both coders agreed the theme was present in the interviewee's responses, a '1' if only one coder identified the theme, and a '0' if neither coder identified the presence of that theme. Given the nature of the interview data, there was no reason to expect significant outliers in the thematic analysis.

3.6 Research Ethics

As an officer of a publicly NASDAQ-listed company, the author was required to annually sign an ethics clause within the company. The research is not only a representation of the author, but a greater responsibility has been entered into to follow academic research-specific ethical rules. This research is founded on a strong ethical belief system and awareness of all university guidelines. The university has an itemized code of ethics that was fully administered to ensure the quality of the final research document. The material represents impartial, neutral, honest work free from exaggeration, embellishment, attachment and personal bias. The dialogue with all companies and individuals was carried out in an honest and confidential manner, and the opinions captured are displayed in an accurate manner free from criticism. The research is intended to extend the understanding of the topic and is of a suitable quality to enhance the existing published material, aid future researchers and enhance the reputation of the university. The thesis is my own work.

Additionally, in 2014, and as previously stated to expand USA interview knowledge of correct interview procedure, extra study on human ethics with the Collaborative Institutional Training Initiative (CITI) was undertaken (Appendix D). Completing the Social/Behavioural course provided the additional reading on ethical, confidentiality, conflicts of interest and consent methodology and papers (Hicks, 2011, Robinson Baily, 2014).

3.7 Summary

The chapter detailed the research's quantitative and qualitative methodology, together with the data collected and the variables used. The chapter also discussed the sample, and provided a breakdown of the seven committees and active members within the

A4WP. For the qualitative component of the study, the chapter described the outcome, conclusion and value of the pilot sample scheme used (Appendix E). The chapter also identified how certain questions from the pilot questionnaire were discarded, and additional questions (Appendix F) were added around important and influential member's behaviour and image based upon the publication of the Bar and Leiponen study in early 2014.

It provided a background and an explanation of the analytical tools and software used in the Social Network and Regression Analysis, and it addressed the subject of ethics and the importance of following the highest standards (Appendix D).

The next chapter provides the results of the various tests performed, together with the testing of the seven hypotheses of the current research.

4. Chapter Four: Analysis and Results

4.1 Introduction

The previous chapter described in detail how the current research has both quantitative and qualitative elements using source material from the A4WP membership database and meeting minutes, together with the 20 face-to-face interviews gathered at four major industry events. This chapter is divided into four sections.

Quantitative 'Regression' Analysis: Analysis was performed on the quantitative alliance data. The current research examines a baseline regression similar to Bar and Leiponen (2014), and then adds additional variables of interest to create a full model to examine the seven hypotheses.

Qualitative 'Theme' Identification Analysis: For the qualitative analysis, the current research was able to introduce results of member behaviour in gaining influence to increase member influence and position in the alliance. The 20 interviews were transcribed and analysed using a thematic analysis approach. The thematic analysis included a frequency approach, a thematic co-occurrence analysis, and a cluster analysis of themes in order to understand the relationship between different sub-themes and determine generic strategies that firms take regarding their involvement in the A4WP standard setting process.

'Graphical' Social Network Analysis: The final method to examine the process of how standard setting may be influenced by companies within a standard setting organisation is to examine the mapping of the various firms. For this graphical analysis I only used data as of October, 2014, showing all 7 subcommittees and at the peak membership of the A4WP.

Summary of Qualitative and Quantitative Results: This section examines the results of both the qualitative and quantitative analyses and draws conclusions as to where they complement each other in explaining the standard setting process and testing the various hypotheses.

4.2 Quantitative Regression Analysis: Data Analysed

4.2.1 Sample and Variable Summary

A regression analysis methodology identifies either a 'dependent' or 'outcome' variable and multiple 'independent' or 'predictor' variables. The current research is interested in committee members who are 'active' members who are actually engaged in making formal proposals for the standards organisation format, technical details and requirements. The present research therefore uses a direct measure of 'standard setting influence' that is, actual standard setting proposals. The direct measure of influence used in the present study is somewhat different from prior research that employ measures of 'engagement and attendance' assuming that engagement and attendance correlates with influence.

The percentage of technology standards proposed per year by a particular active firm is calculated, and then used as the dependent variable. In other words, if 100 technology proposals were made during a year, and Company 'A' contributed 10 of these proposals, the value of the dependent variable for Company 'A' would be 0.10. This measure therefore adjusts for the fact that the number of proposals is different between the three years under review due to an increasing number of working committees each year, and therefore 'normalizes' this measure over time.

The data source of the quantitative material is directly from the A4WP (Alliance for Wireless Power) member-only database and website. The A4WP data (as of October 2014) involved 137 members. The data represents membership information over a three year time period, since the inception of the Alliance. Since there are three years of data, 2012 to 2014, the data is pooled across years resulted in an unbalanced panel. The pooled data has 219 observations. However, not all A4WP firms were members of working committees. Since working committees are primary source for standard proposals, the analysis was also done for a sub-sample of 'active' A4WP firms that were members of one or more working committees. The pooled dataset (also an unbalanced panel) for 'active' members was 92.

As discussed in Chapter 3, various independent or predictor variables were tested to investigate member interaction in leveraging their position with the alliance. Table 6 on the next page itemizes the items included for data analysis (regression) in the present research.

Table 6: A4WP Dependent and Independent Variable Data Collected (Source A4WP)

Dependent Variables	**Details**
Active members	This is active members who attend committee members and propose technical details of the standard. Measured the percentage of proposals within a year that were made by a firm.
Independent Variables	**Details**
Tenure	Time a company has been a member of the A4WP represented as a percentage of the total time since the A4WP was established up to the point when the company joined.
Revenue/Size	Three Categories: <$5M, $5M<$50M, >$50M (US Dollars). Coded as 1, 2, or 3.
Committee Chair	Number of committee chairs held by a particular company.
Committee Member (Test/Certification and Regulation committees)	Dummy variable, member of a particular committee.
Component IP (Intellectual Property membership category)	Membership category for companies that hold patents in wireless power technology and semiconductors.
IP Euclidean Distance (Intellectual Property Patent Numbers)	Number of patents in the wireless field held by a particular company, range 0 to 196. Euclidean testing identified each members list of patents held with the United States Patent Office (USPTO).
Primary Contact	Number of direct contacts in committees (A company can have more than one primary contact is they appear in two or more committees. Calculation follows Bar and Leiponen (2014).
Secondary Contact	Number of Contacts from same member type category. Calculation follows Bar and Leiponen (2014).
Tertiary Contact	Number of contacts that have no committee or member type relationship. Calculation follows Bar and Leiponen (2014).
Freeman's Betweenness	Freeman Betweenness measures the amount of interactions between members. Measure calculated by UCINET.
Freeman's Degree Centrality	Freeman Degree measures the amount of connections between members. Measure calculated by UCINET. Degree centrality was used in Dokko and Rosenkopf (2010).

As per Bar and Leiponen (2014), this current research tested the importance of an IP (intellectual property) portfolio in leveraging influence. The A4WP membership data captured an application type called 'Component/IP'; this is normally seen as a key technology-enabling category (Hagedoorn and Narula, 1999; Hagedoorn and Schakenraad, 2006). Similar to Bar and Leiponen (2014) is the regression of 'connections' to analyse the primary, secondary and tertiary contacts between member companies in leveraging the importance of their individual contribution and influence within the alliance. The revenue/size of member companies were also analysed in this current work.

4.2.2 Calculating the Centrality Measures

UCINET was used to calculate the two centrality measures used in the quantitative portion of the present study. Input to UCINET was accomplished by developing a matrix of member companies for each of the three years under examination, 2012 to 2014. A matrix was constructed for each of the committees, with a '1' entered for the bi-variate connections a company has with all the other companies within that particular committee, and a '0' of a company was not a member of that committee. Thus each committee matrix had a 1-0 matrix of connections between all the companies that where members of the A4WP for that year. For 2012 there were a total of 4 committees, for example. The individual committee matrices where then merged into a master committee connection matrix. Thus if there were 4 committees in a particular year (as in 2012), the maximum connection if a company was a member of all 4 committees with another company that was a member in all 4 committees would be a '4' with the merged master committee connection matrix. 2013 had 5 committees, so the maximum number of connections with another company in the merged 2013 master committee connection matrix would be '5'. 2014 had 7 committees, so the maximum number of connections with another company in the merged 2013 master committee connection matrix would be '7'. This is what is called a 'valued' network matrix since the strength of the actor ties was measured. Each of these yearly master committee connection matrices were inputted into UCINET.

Membership grew from 14 members in 2012, 68 members in 2013 and 137 in 2014 with no member company leaving the A4WP during this time frame. Both Freeman's Degree Centrality and Freeman's Betweenness measures were calculated for each

company for each year. For 2012, the Freeman's Degree Centrality measure ranged between 0 and 0.477, for 2013 it ranged between 0 and 0.287, and for 2014 it ranged between 0 and 0.182. The higher centrality measures for the earlier years reflect the fewer companies that were members of the A4WP group during that year. For the Freeman's Betweenness measure, for 2012 it ranged between 0 and 0.214, for 2013 it ranged between 0 and 0.063, and for 2014 it ranged between 0 and 0.054.

4.2.3 Correlation Table

Tables 7 below measures the means and standard deviations for the predictor variables and table 8 on the following page displays the results on the bivariate correlation tables. Data from active firms only were use for the different variables used in the following regression analysis.

Table 7: Means and Standard Deviations: Predictor Variables (Active Firms)

Variable Name	Mean	S.D.
Tenure	0.57	0.27
Freeman Betweenness	0.03	0.03
Freeman Degree	0.17	0.11
Revenue	2.33	0.86
Tech Committee 2	0.30	0.41
Tech Committee 1	0.79	0.41
Primary Contact	72.1	46.4
Secondary Contact	15.5	22.8
Tertiary Contact	51.9	29.3
USPTO	17.98	34.5
Euclidean Distance	0.69	0.07
Committee Chair	0.17	0.60

Table 8: Bivariate Correlations: Predictor Variables (Active Firms)

Name	Ten	FreeB	FreeD	Rev	Tech2	Tech1	Prim	Sec	Tert	USPTO	Eucl	Chair
Ten	1.00	0.22	0.35	0.29	0.19	0.26	0.30	-0.17	-0.03	0.01	0.11	0.31
FreeB		1.00	0.53	0.18	0.10	0.20	0.17	-0.24	-0.10	0.18	0.03	0.44
FreeD			1.00	0.33	-0.09	0.42	0.11	-0.38	-0.42	0.12	0.47	0.32
Rev				1.00	0.12	0.23	0.17	-0.03	-0.11	0.21	0.06	0.20
Tech2					1.00	0.28	0.63	0.00	0.46	0.15	-0.42	0.08
Tech1						1.00	0.41	-0.21	-0.07	0.06	0.09	0.15
Prim							1.00	-0.51	0.08	0.20	-0.14	0.29
Sec								1.00	-0.17	-0.11	-0.32	-0.18
Tert									1.00	-0.04	-0.56	-0.04
USPTO										1.00	-0.25	0.22
Eucl											1.00	-0.03
Chair												1.00

4.2.4 Regression Analysis: Baseline Model with A4WP Data

4.2.4.1 Review of Bar and Leiponen (2014)

The starting point for the present analysis is to estimate a 'baseline' regression similar to Bar and Leiponen's (2014). Their analysis consisted of the dependent variable of 'supporter' (active members) and independent variables of company size, IP (Intellectual Property), technological distance to source and three types of connections (primary, secondary and tertiary).

It should be noted that the R^2 of the Bar and Leiponen (2014) analysis was 0.071, or 7.1% of the variation in supporter result is explained by the independent variables. Table 9 on the following page lists the details of the independent variables and the results from Bar and Leiponen (2014). I show only the linear regression (OLS Fixed Effects) from the Bar and Leiponen study since this most directly compares with the Tobit regression results used in the present study.

Table 9: Bar and Leiponen Linear Regression (Source Bar and Leiponen, 2014, p.8)

Independent Variable	Coef.	Std. Err.
Connections (Primary)	0.042***	0.006
Connections (Secondary)	0.003***	0.001
Connections (Tertiary)	-0.000	0.001
Euclidean Technology Distance	0.254***	0.052
Revenue/size number	0.022	0.073
Component IP	-0.005	0.008
Constant	0.075	0.086
***=prob<0.01, t-test		
R^2=0.071		

4.2.4.2 Regression Analysis: Baseline Model with the A4WP Data

The regression analysis below shows the results using the pooled A4WP data (2012-2014) as a baseline. Due to possible multi-collinearity issues uncovered during the analysis, I replaced the 'Component IP' variable with a 'Portfolio IP' based upon a patent count from the USPTO. Two different regression models are estimated, a time-controlled Tobit model and a Fixed Effects Tobit model. For the time-controlled Tobit, dummy variables for 2012 and 2013 were used as control. These are not shown in the tables. Since the Fixed Effects uses a mean value to calculate time-based firm effects, no constant is reported for the Fixed Effects regressions. Similarly, *LIMDEP* does not report a pseudo-R^2 for Fixed Effects Tobit regression. Also, since the Revenue/Size variable is invariant (constant) between years (the same for all years for each firm), Fixed Effects regression drops this variable from the analysis.

Table 10 shows the analysis performed for the full pooled database of all A4WP members and a sub-sample of only 'active' A4WP members that are involved in one or more committees. The sub-sample of 'active' members is considered most relevant since only committee members can introduce a technology standard proposal.

Table 10: Baseline with Pooled A4WP Data

Dependent Variable	Influence (Full Sample)		Influence (Active Sample)	
Independent Variable	**Time Controlled Tobit**	**Fixed Effects Tobit**	**Time Controlled Tobit**	**Fixed Effects Tobit**
Connections (Primary)	0.01***	0.00	0.01***	0.00
Connections (Secondary)	-0.01	0.00	-0.00	0.00
Connections (Tertiary)	-0.01*	-0.00	-0.00	-0.00
Euclidean Tech Distance	-0.02	0.14*	0.00	0.14*
Revenue/size number	0.02**	-	0.02**	-
USPTO IP	-0.00	0.01	-0.00	0.01**
Constant	0.09		-0.07	
Decomposition Fit	0.46		0.21	
N	219	219	92	92

=prob<0.10; **=prob<0.05; *=prob<0.01,*

1-tailed, t-test for hypothesis testing since directional hypotheses are proposed

Comparing the present baseline regression (Table 10) with the Bar and Leiponen (2014) results (Table 9) indicates similar results. Bar and Leiponen (2014) found that centrality of connections (Primary and Secondary connections) as well as Euclidean Technology Distance where positively related to support (as they define it) and statistically significant. The findings from the A4WP data (both full membership and 'active' membership) generally support this result. In the present study primary connections (in both time-controlled models) and Euclidean Technology Distance (in both Fixed Effects models) were also positively related to support (as defined in actual proposals presented to the Alliance) and statistically significant. In addition, in the A4WP regression, the variables of firm size (in both time-controlled models) and USPTO IP (in one Fixed Effects model) were also positive, and statistically related to influence when influence is defined as annual percentage of standard setting proposals introduced in the alliance.

Over all, the fit of the baseline regressions using the A4WP data appeared higher that the Bar and Leiponen (2014) regression. While Bar and Leiponen's (2014) regression had an R^2 of only 0.07, although not directly comparable, the present regressions had a pseudo-R^2 (Decomposition Fit) of 0.46 for the full sample, and 0.21 for the 'active' sample.

Even though the dependent variable is censored at the 0-1 limits, the 'active' subsample had a relatively even distribution of the dependent variable throughout the 0-1 range. In these cases, Ordinary Least Squares (OLS) will generally produce unbiased results, even with censored data. Table 11 shows the results for the OLS regressions (time controlled and Fixed Effects) using only the 'active' member subsample. While the OLS Fixed Effects did not have any significant variables in the baseline analysis, the time-controlled regression indicated primary contact and revenue size were positively related to influence, and statistically significant. For this OLS model, the R^2 is 0.36. The results are shown below.

Table 11: Ordinary Least Squares OLS (Time Controlled and Fixed Effects) Baseline with A4WP Data

'Active' A4WP Sample – Influence (Percent Standards) with Contacts	
	Baseline Model
	Time Controlled OLS
Variables	**Influence (%)**
Constant	-0.00
Primary Contact	0.01***
Secondary Contact	0.00
Tertiary Contact	0.00
Euclidean Technology Distance	-0.00
Revenue Size	0.01**
USPTO IP	-0.00
N	92
R^2	0.36
*prob<0.10, **prob<0.05, ***prob<0.01	

4.2.4.3 Regression Analysis: Baseline Model with A4WP Using Freeman's Centrality

Even though as previously discussed, in their study of member influence, Dokko and Rosenkopf (2010) used a direct social network measure of centrality. I therefore also ran the baseline regression using Freeman's Degree Centrality measure instead of the Primary, Secondary and Tertiary contacts variables. Since both methods are designed

to measure a type of 'centrality', due to multi-collinearity issues only the Freeman's Degree Centrality was used in this regression. The results of this regression are shown in Table 12.

Table 12: Baseline (using Freeman's Centrality) with Pooled A4WP Data

Dependent Variable	**Influence (Full Sample)**		**Influence (Active Sample)**	
Independent Variable	**Time Controlled Tobit**	**Fixed Effects Tobit**	**Time Controlled Tobit**	**Fixed Effects Tobit**
Freeman Degree Centrality	0.74***	0.10*	0.59***	0.10*
Euclidean Tech Distance	0.27*	0.11*	0.22	0.11*
Revenue/size number	0.01*	-	0.02**	-
USPTO IP	0.00*	0.01**	0.00	0.01**
Constant	-0.33		-0.28	
Decomposition Fit	0.40		0.12	
N	219	219	92	92

=prob<0.10; **=prob<0.05; *=prob<0.01,* 1-tailed, t-test for hypothesis testing

The results using a direct measure of Centrality (Freemans Degree) produced similar and somewhat more significant results. Freemans Degree Centrality was both positive and statistically significant in all of the models, as was Firm Size (time-controlled model). Both the USPTO IP and the Euclidean Distance variable were positive and statistically significant in three of the four models. Table 13 on the following page shows the OLS regression results (time controlled) for the 'active' sub-sample. This OLS regression produced similar results, with an R^2 of 0.48.

Table 13: Ordinary Least Squares OLS (time controlled and Fixed Effects) Baseline using Centrality

'Active' A4WP Sample – Influence (Percent Standards) with Contacts	
	Baseline Model
	Time Controlled OLS
Variables	**Influence (%)**
Constant	-0.11
Freeman's Degree Centrality	0.40***
Euclidean Technology Distance	0.11
Revenue Size	0.01*
USPTO IP	0.00
N	92
R^2	0.48
*prob<0.10, **prob<0.05, ***prob<0.01	

4.2.4.4 Examining the Baseline Hypotheses

As previously, the baseline regression models were designed to examine the first three hypotheses.

H1: *A firm's intellectual property (IP) portfolios (patent stock) are positively related to standard-setting influence.*

H2: *Centrality in the alliance network is positively related to standard-setting influence.*

H3: *Company size is positively related to standard-setting influence.*

Overall, the regression analysis supports the baseline hypotheses.

For H1, in the majority of the estimated regression models, the technology variables are in the hypothesised direction and statistically significant. This is true for both the Euclidean measure and the USPTO IP measure. A firm's intellectual property position appears to be positively and significantly related to the technology standard setting process. H1 is therefore supported from the regression results.

For H2, in the majority of estimated regression models, the Bar and Leiponen (2014) measure of Primary contacts was statistically significant and in the hypothesised direction. Secondary and Tertiary contacts did not appear to be significantly related to influence. Likewise, in all of the baseline models that used the Freeman's Degree Centrality measure (following Dokko and Rosenkopf, 2010), the centrality variable was

statistically significant and the hypothesised direction. H2 appears to be supported from the regression results.

For H3, in all of the estimated regressions for the baseline, the revenue size model was statistically significant and in the hypothesised direction. H3 is therefore supported from the regression results.

4.2.4.5 Regression Analysis: Full Model with Pooled A4WP Data

The previous section discussed the baseline analysis. The membership data collected from the A4WP, however, included additional member data points, which allowed the current research to expand the number of independent or predictor variables used in regression. Data such as the activity performed by each of the seven committees, year joined (tenure variable) and committee leadership positions (committee chair variable), this additional data allows for the testing of several new independent variables and the testing of the following four additional hypotheses:

H4: *Network Betweenness in the alliance network is positively related to standard-setting influence.* Whereas degree centrality represents the number of connections of a particular node, the Freeman's Betweenness metric quantifies the number of connecting 'nodes' or members each company has. In essence, betweenness measures how much a node within a network is used to join other nodes within the network via the shortest path. (Variable = Freeman's Betweenness Centrality).

H5: *Alliance tenure is positively related to standard-setting influence*. The tenure a company should have a significant effect on the influence of each member company. The hypothesis examines whether the earlier a member firm joins the alliance assists in the gaining of influence within the standards organisation, or is the time of joining not important to the member's ability in gaining a position of influence (Variable = Tenure).

H6: *Committee 'chairmanship' is positively related to standard-setting in influence.* Being a committee chair might increase the influence a member firm can achieve on the standards organisation. This allows the testing of positions of perceived power within the seven committees to see if there is actual control from the chair (leadership) position (Variable = Committee Chair).

H7: *Technical committee membership is positively related to standard-setting in influence.* The activity performed by different committees has different effects on the influence leveraged by each active member. By 2014, the A4WP data had seven committees (one being the Board of Directors). Key committees for the standard setting process are believed to be technical in nature. Two technical committees were in existence during the full period of the A4WP, the Certification/Testing committee and the Regulation committee (2 Variables = Certification/Testing and Regulation Committee Membership).

To examine the additional hypotheses a series of regression were run with the additional four dependent variables added as a 'block'. Adding additional variables as a block is similar to a 'hierarchical regression' process. This represents the full model specification in the quantitative part of the present research. Table 14A presents the results for the Full Sample (2012-2014) compared to the baseline model discussed above using the Freeman's Degrees centrality measure for network connections.

Table 14A: Full A4WP Sample – Influence (Percent Standards) with Centrality

	Baseline Model	**Baseline Model**	**Full Model**	**Full Model**
	Time Controlled Tobit	**Fixed Effects Tobit**	**Time Controlled Tobit**	**Fixed Effects Tobit**
Independent Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Constant	-0.33		-0.33	
Freeman's Degree Centrality	0.74***	0.10*	0.52***	-0.03
Euclidean Technology Distance	0.27*	0.11*	0.30**	0.26***
Revenue Size	0.01*	A	0.01	a
USPTO IP	0.00*	0.00**	0.00	0.00***
Freeman's Betweenness			0.10	0.58***
Tenure			0.05***	0.08***
Committee Chair			0.04***	0.05*
Committee (Test/Cert)			-0.01	-0.01
Committee (Regulation)			0.01	-0.01
N	219	219	219	219
Decomposition Fit Measure	0.40		0.37	
Log-likelihood Function	38.74	94.97	51.50	110.42
*prob<0.10, **prob<0.05, ***prob<0.01 a=variable is constant between years				

I do this analysis with both the Freeman's Centrality measure and the 'Primary, Secondary, and Tertiary' connections. This comparison is important not only to test H4 to H7 in a hierarchical manner, but also to make sure that adding additional variables does not significantly change the coefficient estimates for the baseline variables, thus indicating possible multicollinearity issues. Both the time-controlled Tobit and Fixed Effects Tobit regression estimates (using Freeman's Degree Centrality) for the full sample are shown.

Table 14B presents the results for the Full Sample (2012-2014) using the measures of Primary, Secondary and Tertiary contacts. Both the time-controlled Tobit and Fixed Effects Tobit regression estimates are shown.

Table 14B: Full A4WP Sample – Influence (Percent Standards) with Contacts

	Baseline Model	**Baseline Model**	**Full Model**	**Full Model**
	Time Controlled Tobit	**Fixed Effects Tobit**	**Time Controlled Tobit**	**Fixed Effects Tobit**
Independent Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Constant	0.09		-0.03	
Primary Contact	0.01***	0.00	0.01***	0.01***
Secondary Contact	-0.01	0.00	-0.00	0.01**
Tertiary Contact	-0.01*	-0.00	-0.00	-0.00
Euclidean Technology Distance	-0.02	0.14*	-0.02	0.28***
Revenue Size	0.02**	a	0.01*	A
USPTO IP	-0.00	0.01**	-0.00	0.00***
Freeman's Betweenness			0.26*	0.67***
Tenure			0.04*	0.09***
Committee Chair			0.39***	-0.05*
Committee (Test/Cert)			-0.00	0.00
Committee (Regulation)			0.03*	0.00
N	219	219	219	219
Decomposition Fit Measure	0.46		0.44	
Log-likelihood Function	35.03	95.56	45.93	118.92
*prob<0.10, **prob<0.05, ***prob<0.01 a=variable is constant between years				

The same analysis is also done for the 'Active' member firms. Table 14C presents the results for the sub-sample of only 'Active' member firms (2012-2014) using the Freeman's Degrees centrality measure for network connections. Both the time-controlled Tobit and Fixed Effects Tobit regression estimates are shown.

Table 14C: 'Active' A4WP Sample – Influence (Percent Standards) with Centrality

	Baseline Model	Baseline Model	Full Model	Full Model
	Time Controlled Tobit	Fixed Effects Tobit	Time Controlled Tobit	Fixed Effects Tobit
Independent Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Constant	-0.28		-0.30	
Freeman's Degree Centrality	0.59***	0.10*	0.40***	-0.00
Euclidean Technology Distance	0.22	0.11*	0.27***	0.26***
Revenue Size	0.02**	a	0.01	A
USPTO IP	0.00	0.01**	0.00	0.01***
Freeman's Betweenness			0.12	0.58***
Tenure			0.05**	0.07***
Committee Chair			0.03***	-0.05*
Committee (Test/Cert)			-0.00	-0.01
Committee (Regulation)			0.00	0.00
N	92	92	92	92
Decomposition Fit Measure	0.12		0.15	
Log-likelihood Function	43.05	94.97	55.49	110.42
*prob<0.10, **prob<0.05, ***prob<0.01 a=variable is constant between years				

Table 14D presents the results for the 'Active' member sub-sample (2012-2014) using the measure of Primary, Secondary and Tertiary contacts. Both the time-controlled Tobit and Fixed Effects Tobit regression estimates are shown.

Table 14D: 'Active' A4WP Sample – Influence (Percent Standards) with Contacts

	Baseline Model	Baseline Model	Full Model	Full Model
	Time Controlled Tobit	Fixed Effects Tobit	Time Controlled Tobit	Fixed Effects Tobit
Independent Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Constant	-0.07		-0.17	
Primary Contact	0.01***	0.00	0.01***	0.01***
Secondary Contact	-0.00	0.00	-0.00	0.01**
Tertiary Contact	-0.00	-0.00	-0.00	-0.00
Euclidean Technology Distance	-0.00	0.14*	0.09	0.28***
Revenue Size	0.02**	a	0.01*	A
USPTO IP	-0.00	0.01**	0.00	0.01***
Freeman's Betweenness			0.23**	0.67***

Table 14D (continued): 'Active' A4WP Sample – Influence (Percent Standards) with Contacts

	Baseline Model	Baseline Model	Full Model	Full Model
	Time Controlled Tobit	Fixed Effects Tobit	Time Controlled Tobit	Fixed Effects Tobit
Independent Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Tenure			0.05**	0.09***
Committee Chair			0.04***	-0.057*
Committee (Test/Cert)			-0.01	0.01
Committee (Regulation)			0.02	-0.01
N	92	92	92	92
R2				
Anova-based Fit Measure	0.60		0.37	
Decomposition Fit Measure	0.21		0.16	
Log-likelihood Function	41.96	95.56	53.45	119.92
*prob<0.10, **prob<0.05, ***prob<0.01 a=variable is constant between years				

Finally, Table 14E presents the Ordinary Least Squares (OLS) results for the 'Active' member subsample (2012-2014).

Table 14E: Ordinary Least Squares (OLS) results for the 'Active' Sample

	Baseline Model	Baseline Model	Full Model	Full Model
	Time Controlled OLS	Fixed Effects OLS	Time Controlled OLS	Fixed Effects OLS
Variables	**Influence (%)**	**Influence (%)**	**Influence (%)**	**Influence (%)**
Constant	-0.11		-0.17	
Freeman's Degree Centrality	0.40***	0.11*	0.26***	-0.01
Euclidean Technology Distance	0.11	0.03	0.19*	0.21***
Revenue Size	0.01*	a	0.00	A
USPTO IP	0.00	0.00	0.00	0.01*
Freeman's Betweenness			0.11	0.58***
Tenure			0.03**	0.08***
Committee Chair			0.04***	-0.04
Committee (Test/Cert)			-0.00	-0.00
Committee (Regulation)			0.00	-0.00
N	92	92	92	92
R2	0.48	0.15	0.67	0.60
*prob<0.10, **prob<0.05, ***prob<0.01 a=variable is constant between years				

Table 14E displays the Freeman's Degree centrality measure for network connectivity. Since the 'Active' subsample only includes A4WP members that were members of one or more working committees, there is less clustering of the dependent variable at the censored limit (0). In this case, OLS may provide reasonably unbiased parameter estimates. Both the time controlled OLS and Fixed Effects OLS regression estimates are shown.

4.2.4.6 Fully Specified Regression Model: Fit and Multicollinearity

Fit measures for non-linear Tobit models are sometimes difficult to interpret. In general, the estimated models all appeared to provide reasonably good fit. For the Tobit regression models, overall model significance is generally assessed by the Log-Likelihood Chi-Square function. All of the regressions models were statistically significant.

As previously mentioned, Tobit regression also uses various pseudo-R^2s. *LimDep* reports the Decomposition Fit measure. The Decomposition Fit measure is a pseudo-R^2s that is calculated as the variance of the conditional mean function around the overall mean of the data in the numerator (Greene, 2002). However, the Decomposition Fit measure should not be directly compared to the R^2 of OLS. In addition, since each Tobit regression results in a different non-linear estimate, pseudo-R^2s from different regression estimates should be compared with each other only with caution.

The final model was also examined for multicollinearity. For the active firm subsample, only one variable pair of variables used in the regressions (Tertiary Contact-Euclidean IP) had a bivariate correlation above 0.60. Another indication of potential multicollinearity is when a variable is added to the equation it changes the estimated coefficient of another variable significantly (direction and/or statistical significance). Overall, adding the additional variables for the full model did not significantly change the direction of the baseline variables in most cases. There were differences in statistical significance in some case, but not major differences when examining the full range of regression models that were estimated. In general, the regressions appeared relatively stable.

In addition, to address potential multicollinearity issues, Primary contacts (from Bar and Leiponen, 2014) and Freeman Degree Centrality were not used in the same regression.

Also, Component IP (as measured in Bar and Leiponen, 2014) was correlated with the Euclidean measure, so the research used the USPTO measure instead (which had lower correlation with the Euclidean measure).

Finally, while the Tobit and Fixed Effects models in *LimDep* do not report a variance inflation factor (VIF), the VIFs for the OLS models were all below 5.0, indicating non-critical levels of multicollinearity. The Ordinary Least Squares (OLS) results for the 'Active' member subsample.

4.2.4.7 Full Model with A4WP New Data: Discussion

Finally, overall, the regression analysis supports three of the four additional hypotheses.

H4: The Freeman's Betweenness centrality quantifies the number of connecting 'nodes' or members each company has. In essence, Freeman's Betweenness measures how much a node within a network is used to join other nodes within the network via the shortest path. In seven out of ten of the estimated regressions shown in Tables 14A to 14E, the Freeman's Betweenness is statistically significant and in the hypothesised direction. H4 is therefore supported.

H5: Tenure represents the length of time a member has been involved in the A4WP. It is hypothesised that the longer involved in the standard alliance, the more influence that firm will have. The Tenure variable is statistically significant and in the hypothesised direction in all of the estimated models shown in Tables 14A to 14E. H5 is therefore supported from the regression results.

H6: A firm holding a position as a Committee Chair is expected to have more influence. In general, this hypothesis is supported. In five of the estimated full model equations, Committee Chair is statistically significant and in the hypothesised direction. However, in two of the models, Committee Chair is statistically significant but opposite from the hypothesised direction. This may actually indicate a multicollinearity problem between the Committee Chair and another variable in the equation. This will be discussed later. However, given that in five of the estimated regressions the variable is in the hypothesised direction indicates general support for H6.

H7: Is not supported from the estimated models. Membership in the two subcommittees (Certification/Test and Regulation) had statistical significance in only one regression model. H7 is therefore not supported.

4.3 Summary and Conclusions of Linear Regression

The regressions, in section 9.2.4.2 and the testing of the block of additional independent variables in the hierarchical multiple regression in section 9.2.4.5 allowed a comparison with A4WP data with the results of Bar and Leiponen (2014) analysis of a different standard setting organisation. Table 15 below lists the seven hypotheses and the results.

Table 15: Results of Regression

Hypothesis	Accepted/ Rejected
H1: A firm's intellectual property (IP) portfolios (patent stock) are positively related to standard-setting influence (Baseline).	**H1 Accepted**
H2: Centrality in the alliance network is positively related to standard-setting influence. (Baseline).	**H2 Accepted**
H3: Company size is positively related to standard-setting influence (Baseline).	**H3 Accepted**
H4: Network Betweenness in the alliance network is positively related to standard-setting influence.	**H4 Accepted**
H5: Alliance tenure is positively related to standard-setting influence.	**H5 Accepted**
H6: Alliance tenure is positively related to standard-setting influence.	**H6 Accepted**
H7: Technical committee membership is positively related to standard-setting in influence.	**H7 Not-Supported**

4.4 Qualitative Data: 20 Interview Results and Analysis

4.4.1 Background

While the regression analysis was used to examine the specific hypotheses, the qualitative analysis allows for a more in-depth understanding of the standard setting process. Access and availability for 20 interviews presented itself during four key events from late 2013 and early 2014 by member executives travelling to the events and making themselves available for an interview. The interviewees are amongst the most active key executives of the consortium including the president, chairs, vice chairs and director members from each of the main working groups of technical and marketing teams. As discussed in Chapter 3, a sample size of 20 semi-structure interviews is typical for a thematic content analysis. Access was approved by the president of the A4WP who also agreed to take part in the interview process.

Major wireless power events that gathered the executives together in one location were chosen to facilitate the necessary travel, appointment times and logistics needed to arrange the face-to-face interviews.

Two events were identified to execute the pilot interviews. The first event opportunity for initial interviews was the two-day A4WP general meeting in Austin, Texas, USA in December 2013. During this annual event a general Wireless Power Summit was held and drew a large A4WP membership attendance. The second event was the Consumer Exhibition Show (CES) is held in Las Vegas, Nevada, USA every January, 2014 and is strongly supported by members.

Following the pilot test, the author was limited to two additional events to perform the extended face-to-face interviews. The first event was the Mobile World Congress (MWC) in February, 2014 held in Barcelona, Spain which is the largest of the worldwide events and attracts the most member attendees annually. There was also an Annual General Meeting (AGM) March, 2014 held in Milpitas, California, USA. For each of the identified events and meeting opportunities the author arranged a meeting room or suitable area, recording equipment and discussed the confidentiality agreement to support the face-to-face interviews with the targeted executive members.

Additional observations were made during a members' meeting in July, 2014 in Seoul, South Korea sponsored by Samsung, an A4WP board member company.

The qualitative interview responses were analysed to produce conclusions and observations of the attitudes, motivations and expectations of the members. This qualitative data analysis addressed the research question and added value to existing current research on competitor behaviour in standards-based alliances.

Three different techniques were used in the qualitative analysis: a frequency analysis of themes, a thematic co-occurrence analysis, and a cluster analysis of themes to identify generic strategies within the standard setting consortium.

4.4.2 Qualitative Data: Confidentiality and Permission

Prior to every face-to-face interview (6 pilot interviews and 14 full interviews) I read the same statement to each interviewee. **"**I just want to explain something. I'm carrying out research for my doctorate for the Heriot Watt University. The (A4WP president) has given permission to approach the members and discuss the value of consortia and why companies join consortia. This is confidential, it's academic research your name will not be used and the information will not be shared with my company IDT".

Table 16 lists the 20 interviewees who agreed to proceed and no further assurance was requested by any of the executives. The interviews were all executed within one hour.

Table 16: Details of Interviews

Interviewee	**Job Title**	**Interview Venue & Date**
Test Pilot One	Technical Manager at IDT	Austin Texas, December 3rd 2013
Test Pilot Two	Director Marketing at IDT	Austin Texas, December 4th 2013
Test Pilot Three	Director at Intel	Austin Texas, December 6th 2013
Test Pilot Four	Director Qualcomm	Austin Texas, December 6th 2013
Test Pilot Five	Director Marketing at IDT	Austin Texas, December

		6th 2013
Test Pilot Six:	Director Marketing at Gill	Las Vegas January 8th 2014
Interview One	Director at Samsung	Barcelona February 24th 2014
Interview Two	Senior Mgr Qualcomm	Barcelona February 25th 2014
Interview Three	European Sales Director at Gill	Barcelona February 25th 2014
Interview Four	Director Intel	Barcelona February 25th 2014
Interview Five	Director at On Semi	Barcelona February 27th 2014
Interview Six	Director at WiTricity	Barcelona February 27th 2014
Interview Seven	Director at Maxim Semi	Milpitas, March 10th 2014
Interview Eight	Manager at Intel	Milpitas, March 10th 2014
Interview Nine	Senior Manager at Intel	Milpitas, March 10th 2014
Interview Ten	Director at IDT	Milpitas, March 10th 2014
Interview Eleven	Director at Qualcomm	Milpitas, March 10th 2014
Interview Twelve	Manager at Wi-Tricity	Milpitas, March 11th 2014
Interview Thirteen	VP at Qualcomm	Milpitas, March 11th 2014
Interview Fourteen	Director at Broadcom	Milpitas, March 11th 2014

4.4.3 Qualitative Data: Questions

A total of sixteen questions were asked during the recorded interviews with the 20 members. For the present research, the responses to eight 'major questions' were examined. Both the pilot and full interviews were used in this analysis.

These eight 'major questions' generated a series of themes per question from the answers given by the 20 face-to-face interviewees. The keywords were identified by a detailed review of the full interview transcripts based upon the most often used word, name or phrase. As Jaewoo and Woonsun (2013) notes, "such research may be either frequency analysis, which analyzing how often titles or keywords of papers appear in papers" (Jaewoo and Woonsun, 2013, p.172).

Table 17 below illustrates the themes connections per each question.

Table 17: Details of Major Questions

Questions analysed, Hypotheses Addressed and Connection to Other Questions	Themes of Question
Q1: Why is your company a member?	a. Grow business b. Company Profit c. IP positioning d. Learning from other members IP e. Understanding early the technical specs to suit own company f. Following all developing market trends
Q3b: Company stated objective?	a. Clear stated objective b. Not clear objective c. Product positioning d. IP positioning within specification e. Revenue targets f. Early access to technical spec
Q4: What are the perceived risks of membership?	a. Risks been considered b. Did not consider risks c. Not concerned about risks d. Risks of IP infringements by competitors e. Risk of competitors blocking progress f. Risks of A4WP failing
Q5: Value of membership to your product?	a. Direct placement of your product within standards spec b. Learning and influencing the

	specification for your products c. Advancing the time to market of your products d. Creating a market to adopt your products
Q6: Innovation advantage/IP sharing?	a. Learning from others IP b. Teaching others your IP c. Conducting and selling its IP to potential licensees d. Protecting its companies IP e. Profiting from its IP f. Promoting it IP strengthens the legal protections of the IP
Q8: Which type of company within the A4WP do you talk to the most?	a. BoD members or large companies only b. Gaining maximum contacts to leverage their position c. Potential clients for our IP d. Suppliers that will help bring the end product to market e. Companies that can help your product success f. Companies that your hope to become customers
Q9: Who are in your opinion the most important members of the A4WP and why?	a. BoD members or large companies only b. Other smaller important members c. Chairs of committees d. Founding members
Q13: Who do you think is the member company able to make the A4WP standard successful? List three members...	a. Large companies b. BoD only c. Other smaller more important members d. Those companies with IP positioned in the tech spec e. Early members of the standards org

4.4.4 Inter-coder Agreement

A two-coder system was used to avoid bias and errors. The author was the first coder. The second coder was a contact in a previous MSc research thesis. The list of themes was presented to each coder, who then read the full transcript for each interviewee. For each question, each coder recorded a '1' if the coder felt that particular theme was present for that particular respondent and a '0' if it was not included. Each coder

analysed the transcripts separately and noted their findings into a series of NxM matrices, where N=themes per question, and M=respondents per question.

There are several methods to measure inter-coder agreement. One of the simplest methods is to examine the percentage of agreement. With the current research the amount of two coder agreements were 97.8% with 2 or less discrepancies. Table 18 shows the range of coder agreement.

Table 18: Coder Agreement Percentages

90 Themes Reviewed for 20 Interviews by Two Coders	Percentage of Agreement
Amount of times agreed exactly	26.6%
Disagreed by only one '1's' or '0's' per theme for the 20 interviews	46.6%
Disagreed by only two '1's' or '0's' per theme for the 20 interviews	24.4%
Disagreed by greater than two '1's' or '0's' per theme for the 20 interviews	2.2%

A more sophisticated inter-coder agreement analysis was also undertaken. In a two-coder, multi-theme process, an appropriate measure of inter-coder agreement is the 'Fuzzy Kappa'. The 'Fuzzy Kappa' index is used to "assess the agreement between coders when content is classified into multiple categories" (Kirilenko and Stepchenkova, 2016, p.5). Kirilenko and Stepchenkova (2016) also note that the, "fuzzy kappa is calculated in a case of classical one-to-one coding within a two-tier category system and, thus, can be viewed as integration of multiple crisp indices into one single indicator" (Kirilenko and Stepchenkova, 2016, p.5).

Table 19 on the following page displays the results of the Fuzzy Kappa two coder test for the eight questions. As shown, no question measured below a 'moderate' inter-coder agreement score and three of the eight questions measured an 'almost perfect agreement' score.

Table 19: Fuzzy Kappa Coder Agreements

Kappa Agreement Range and Significance	Actual Fuzzy Kappa measured (for the eight questions)
Poor <0.0	None
Slight 0.01-0.20	None
Fair 0.21-0.40	None
Moderate 0.41-0.60	Q1: 0.5922 Q4: 0.5120 Q5: 0.4325
Substantial 0.61-0.80	Q6: 0.7074 Q8: 0.6942
Almost Perfect 0.81-0.99	Q13: 0.8052 Q3B: 0.8326 Q9: 0.8828

4.4.5 Thematic Analysis – Frequency

Within this section I analysed the themes for each of the eight 'major questions'. The first approach reports the total percentage, or frequency, themes were mentioned for each of the eight questions for the 20 face-to-face interviews. If one, or both, of the coders reported the presence of a theme then it was recorded in the analysis. Table 20 reports the comparison of the themes for each of the eight questions.

Table 20: Code Frequency by Percentage

Questions	Themes of Question	
Q1: *Why is your company a member?*	95%	Grow business
	20%	Company Profit
	40%	IP positioning
	45%	Learning from other members IP
	60%	Understanding early the technical specs to suit

		own company
	100%	Following developing market trends
Q3b *Desired outcome for company?*	40%	No clear objective
	90%	Product positioning
	60%	IP positioning within specification
	50%	Revenue targets
	55%	Early access to technical spec
Q4 *Perceived risks?*	5%	Did not consider risks
	40%	Not concerned about risks
	50%	Risks of IP infringements by competitors
	35%	Risk of competitors blocking progress
	45%	Risks of A4WP failing
Q5 *Value of membership to your product?*	90%	Direct placement of your product within standards spec
	65%	Learning and influencing the specification for your products
	75%	Advancing the time to market of your products
	95%	Creating a market to adopt your products
Q6 *Innovation advantage/IP sharing?*	55%	Learning for others IP
	80%	Teaching others your IP
	30%	Conducting and selling its IP to potential licensees
	50%	Protecting its companies IP
	30%	Profiting from its IP
	25%	Promoting it IP strengthens the legal protections of the IP
Q8 *Who do you talk to most?*	65%	BoD members or large companies only
	30%	Gaining maximum contacts to leverage their position
	30%	Potential clients for our IP

	40%	Suppliers that will help bring the end product to market
	55%	Companies that can help your product success
	45%	Companies that your hope to become customers
Q9 *Who is most important?*	65%	BoD members or large companies only
	15%	Other smaller important members
	60%	Chairs of committees
	45%	Founding members
Q13 *Who will make the A4WP a success?*	70%	Large companies
	55%	BoD only
	15%	Other smaller more important members
	40%	Those companies with IP positioned in the tech spec
	25%	Early members of the standards org

The frequency table provides a percentage representation of the importance of each identified theme within the interview transcripts.

Q1: Why is your company a member? The top two themes were 'following market trends' and 'growing the business'. The least mentioned theme was 'profit'.

Q3b: Desired outcome for your company? The major theme was 'product' positioning related rather than 'IP' or 'tech' access. The question did identify that only 40% of member companies didn't declare an objective for A4WP activity. Question one tests if members seek to position their IP by becoming a member, the IP theme was not as highly coded as 'product' but was the second highest theme which supports H1.

Q4: Perceived risks of membership? All but one company 'did consider the risks', the highest themes identified concerns about competitors infringing on their 'IP' and the 'risks of the entire A4WP venture failing'.

Q5: Value of membership to your product? The members declared themes related to their products either 'adopting', 'placing' and 'advancing' within the A4WP specs and achieving market penetration.

Q6: Innovation advantage/IP sharing? The subject of technology innovation and intellectual property prompted themes to emerge as the most popular around teaching and learning, both these themes have a strong element of competitor interaction which the association environment facilitates. Hypothesis one in the quantitative section is directly concerned with the positioning of intellectual property. Question six in the qualitative analysis appears to add support to H1.

Q8: Which company do you talk to most? The 'Board of Directors' and other 'large' company's was the theme which the interviewee's expressed the most. While 'finding clients for IP' and 'leverage their positions' were less evident. The theme of large companies being the highest in the frequency code does appear to support the findings of H3 in the quantitative analysis.

Q9: Which member of the A4WP is the most important? Similar to question eight and in support of the 'Board of Director's' were the highest identified theme, however two themes which was mentioned highly were 'Committees Chairs' and 'Founding Members'. These two themes directly address H5 and H6 from this research. Hypothesis five explores the tenure of members and questions if members gain an advantage from being a 'founder' and does joining early assist in gaining influence. Hypothesis six tests if being the chair of a committee is a vehicle to gain influence to the A4WP standards. Both these themes were positively identified in the analysis.

Q13: Which member company will make the A4WP standard a success? The popular themes which developed from the frequency coding were 'Large Companies' and the 'Board of Directors' is similar data than that of question eight and nine. The identification of these two themes as dominant adds support to H3 (large companies) and H6 (committee chairs). Large company members were the highest theme in the coded answers for method of success in support of H3. 'Chair positions' of committees within the data analysed are also on the 'Board of Directors' which was the second highest theme identified positively supporting H6.

4.4.6 Thematic Analysis – Co-occurrence Analysis

This section presents an in-depth analysis of each theme in relationship to the other themes within the eight 'major questions'. As Olemeda-Gomez et al., (2017) explain, "in a co-word analysis, content is explored through the co-occurrence of pairs of terms or lexemes (such as words or phrases)" (Olmeda-Gomez et al., 2014 p.195). A co-occurrence analysis provides an opportunity to create a 'thematic landscape,' and identify the relationships between themes, and importance/relevance of these themes as they relate to the question being asked.

This research analyses the co-occurrences of themes using a three-stage process. First a 'saliency' or 'proximity matrix' was formed for each question. This displays the number of times a theme was mentioned with each of the other themes for that particular question among the 20 interviewees. For example, for a particular question an entry of '8' in the saliency matrix would indicate that in 8 out of the 20 interviews these two themes were mentioned together by the interviewees. This follows the approach as described in Guest and Mclellan, (2003). They define saliency as, the "number of times that a code occurred within a combination of codes delineated by either text segments or respondents (note that, in theory, a code that repeatedly occurs in isolation may exhibit high frequency but have low to no saliency" (Guest and Mclellan, 2003, p.191). If either of the two coders identified a theme for a particular question, it is included in the saliency matrix. Since this matrix shows 'strength' of co-occurrence (numbers greater than 1 or 0) this is considered a 'valued' matrix.

Secondly, the saliency matrix is then used as input to the UCINET 'NetDraw' function. The NewDraw program is used to produce illustrative diagrams that creates arrow's to directly link the strength of each connected theme. Essentially, the themes represent a network of relationships, but rather than communication relationships as in a typical social network study, this network represents the relationship of themes. In this context, the thicker the arrow the stronger the link between themes and themes with inbound arrows indicates themes that are closer or more directly related, to the actual question being asked. Themes with outbound arrows indicate 'precursor' themes or more general, broad themes. While the arrows do not represent causality, they do represent precursor/descendant thematic relationships.

In the third step, the 'centrality' of each theme within the eight questions was calculated. The centrality index used was the eigenvector centrality measure. Eigenvector centrality focuses on the importance of each node of contact and is a non-directional measure of centrality or importance.

To interpret the co-occurrence analysis, it is the combination of high eigenvalue centrality (Step 3) with a theme having multiple inbound arrows (Step 2) that generally indicates the most important themes that are directly related to the specific question being asked of the respondents. This gives a deeper understanding of the most important themes versus a simple frequency analysis of themes.

4.5 Co-occurrence Theme Analysis of the Eight 'Major' Questions

Question One: Question one generated six identifiable themes which appear below in a theme saliency input matrix.

	Grow Business	Profit	IP Positioning	Learning Other IP	Understanding Standards	Follow Market Trends
Grow Business		5	9	11	13	18
Profit			4	5	5	5
IP Positioning				8	8	9
Learning Other IP					11	11
Understanding Standards						13
Follow Market Trends						

From this, the 'NetDraw' program generated a visualisation of the thematic network (Figure 14).

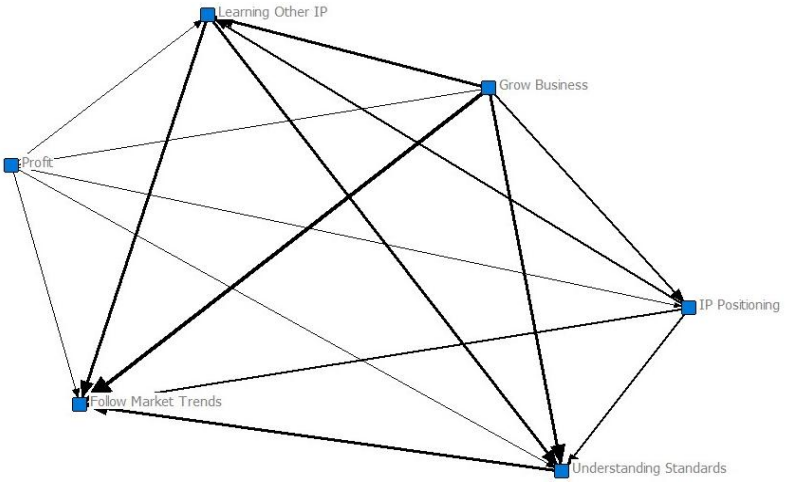

Figure 14: NetDraw Analysis of Question One

From this diagram it is clear that the two themes having a majority of inbound arrows are 'Understanding Standards' and 'Following Market Trends'. This indicates these themes are most directly aligned to what question one is actually asking. On the other hand, the themes 'Profit' and 'Grow Business', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes.

Table 21 is an interpretation of the themes involves combining Step 2 with Step 3. While 'Grow Business' has a high centrality index (0.486), the key themes most directly related to the question (with inbound arrows) 'Following Market Trends' and 'Understanding Standards' also have high centrality (0.486 and 0.440 respectively). Thus, it can be concluded from the co-occurrence analysis, that the key and more direct responses to the question, "Why is your company a member?" are 'Following Market Trends' and 'Understanding Standards', and that 'Growing the Business', while important, is a more general, and less direct response to the question.

Table 21: Question One Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	**Low - High Importance**
1 Grow Business	0.486
2 Profit	0.220
3 IP Positioning	0.345
4 Learning Other IP	0.407
5 Understanding Standards	0.440
6 Follow Market Trends	0.486

Question Three B: Generated five identifiable themes which appear below in a theme saliency input matrix.

	No objective	Product Positioning	IP Positioning	Revenue	Access to Tech
No objective		7	2	4	5
Product Positioning			12	10	12
IP Positioning				8	10
Revenue					8
Access to Technology					

From this, the 'NetDraw' program generated a visualisation of the thematic network (Figure 15 below). From this diagram the two themes having a majority of inbound arrows are 'Access to Technology' and 'Revenue'. This indicates these themes are most directly aligned to what question three B is actually addressing. On the other hand, the theme 'No Objective' and less so 'Product Positioning', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes.

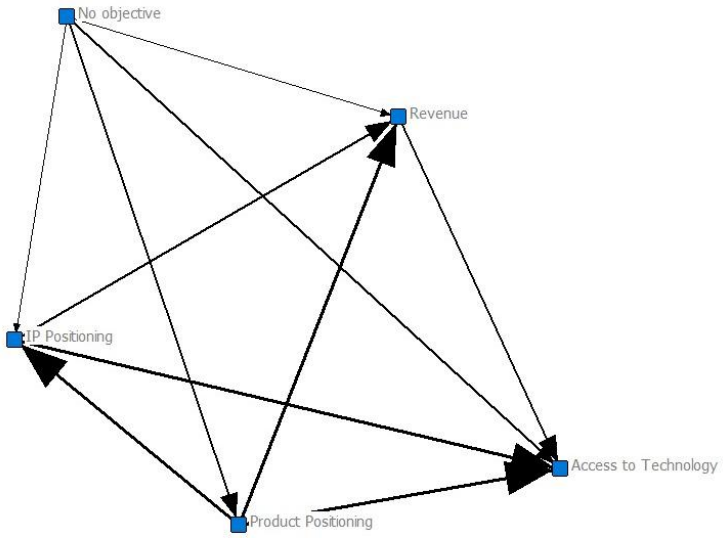

Figure 15: NetDraw Analysis of Question Three B

Table 22 is an interpretation of the themes involves combining Step 2 with Step 3. While 'Product Positioning' has a high centrality index (0.538), the key themes most directly related to the question (with inbound arrows) 'Access to Technology' and 'Revenue' also have high centrality (0.486 and 0.467 respectively). Thus, it can be concluded from the co-occurrence analysis, that the key, and more direct responses to the question, "Desired outcome for your company?" are 'Revenue', 'Access to

Technology' and 'IP Positioning', and that 'Product Positioning', while important, is a more general, and less direct response to the question.

Table 22: Question Three B Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 No objective	0.270
2 Product Positioning	0.538
3 IP Positioning	0.467
4 Revenue	0.430
5 Access to Technology	0.486

Question Four: Generated five identifiable themes which appear below in a theme saliency input matrix.

	Did not consider risks	Not concerned about risks	Risks of IP infringements	Risks of competitors blocking progress	Risks of A4WP failing
Did not consider risks		1	1	0	1
Not concerned about risks			6	4	3
Risks of IP infringements by competitor				5	4
Risks of competitors blocking progress					4
Risks of A4WP failing					

From this, the 'NetDraw' program generated a visualisation of the thematic network (Figure 16 on the following page). From this diagram the theme having the majority of inbound arrows is 'Risks of the A4WP Failing'. This indicates this theme as most directly aligned to question four. On the other hand, the themes 'Not Concerned About Risks' and 'Did Not Consider Risks', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes.

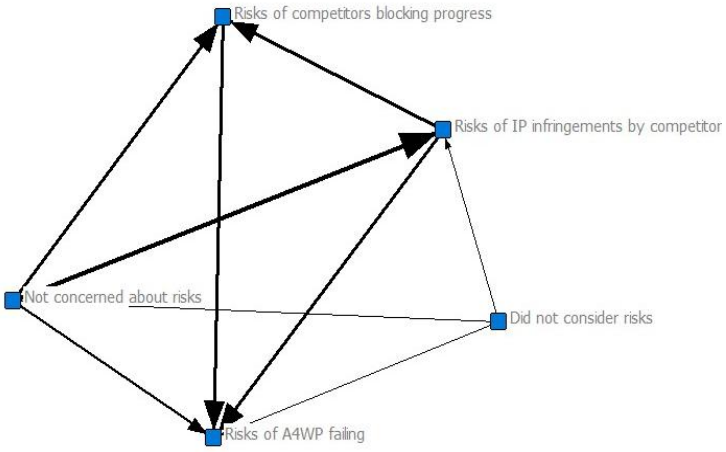

Figure 16: NetDraw Analysis of Question Four

Table 23 is an interpretation of the themes involves combining Step 2 with Step 3. While 'Risks of IP Infringement' has the highest centrality index (0.551), the key themes most directly related to the question (with inbound arrows) 'Risks of the A4WP Failing' and 'Risks of Competitors Blocking) also have high centrality (0.436 and 0.490 respectively). From the co-occurrence analysis it appears that the direct responses to the question, "Perceived risks of membership?" are 'Risks of A4WP Failing' and Risks of IP Infringement' and 'Risk of Competitors Blocking', and that 'Not Concerned About Risks', while important, is a more general, and less direct response to the question.

Table 23: Question Four Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 Did not consider risks	**0.112**
2 Not concerned about risks	**0.503**
3 Risks of IP Infringements	**0.551**
4 Risks of Competitors Blocking	**0.490**
5 Risks of A4WP failing	**0.436**

Question Five: Generated four identifiable themes which appear below in a theme saliency input matrix.

	Placement of firm technology into industry standards	Learning and influencing specs for firm technology	Advancing time to market of firm technology	Creating market for firms existing technology
Placement of firm technology into industry standards		16	14	18
Learning and influencing specs for firm technology			12	15
Advancing time to market of firm technology				15
Creating market for firms existing technology				

The 'NetDraw' program generated a visualisation of the thematic network for the responses from this question (Figure 17). From this diagram the theme having a majority of inbound arrows is 'Creating Market for Products'. This indicates this theme is the most directly related to question five. On the other hand, the themes 'Placement of Members Tech' and 'Advancing Time to Market', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes to the other themes identified.

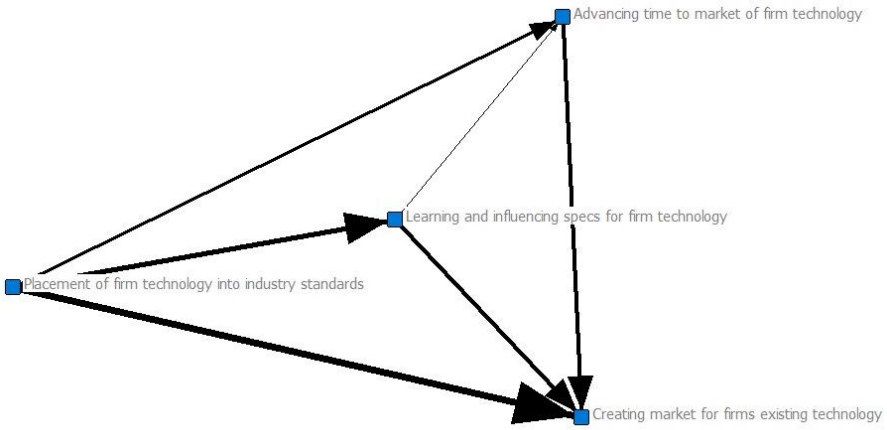

Figure 17: NetDraw Analysis of Question Five

Table 24 is an interpretation of the themes involves combining Step 2 with Step 3. While 'Placement of Members Tech' has a high centrality index (0.524), the key theme most directly related to the question (with inbound arrows) 'Creating a Market for Products' also has a high centrality (0.524). Thus it can be concluded from the co-occurrence analysis, that the most important and more direct responses to the question, "Value of membership to your product?" is 'Creating a Market for Products' and slightly less important but with high centrality scores are 'Learning and Influencing Spec' and 'Advancing Time to Market' (0.484 and 0.465 respectively), and that

'Placement of Members Tech', while important, is a more general, and less direct response to the question.

Table 24: Question Five Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 Placement of Members Tech	**0.524**
2 Learning and Influencing Spec	**0.484**
3 Advancing Time to Market	**0.465**
4 Creating a Market for Products	**0.524**

Question Six: Generated six identifiable themes which appear below in a theme saliency input matrix.

	Learning from others' IP	Teaching others your IP	Selling IP to potential licensees	Protecting your firm's IP	Profiting from firm's IP	Strengthen legal position of IP
Learning from others' IP		12	2	2	5	4
Teaching others your IP			6	6	8	8
Selling IP to potential licensees				6	5	6
Protecting your firm's IP					5	6
Profiting from firm's IP						6
Strengthen legal position of IP						

Similarly, for question six the 'NetDraw' program generated a visualisation of the thematic network (Figure 18 on the next page). From this diagram three themes are identified as having a majority of inbound arrows. These are 'Strengthen Legal Position', 'Protecting your Firms IP' and 'Profiting from Firm's IP'. This indicates these themes are most directly aligned to what question six. On the other hand, the themes 'Learning from others IP' and 'Teaching others your IP', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes.

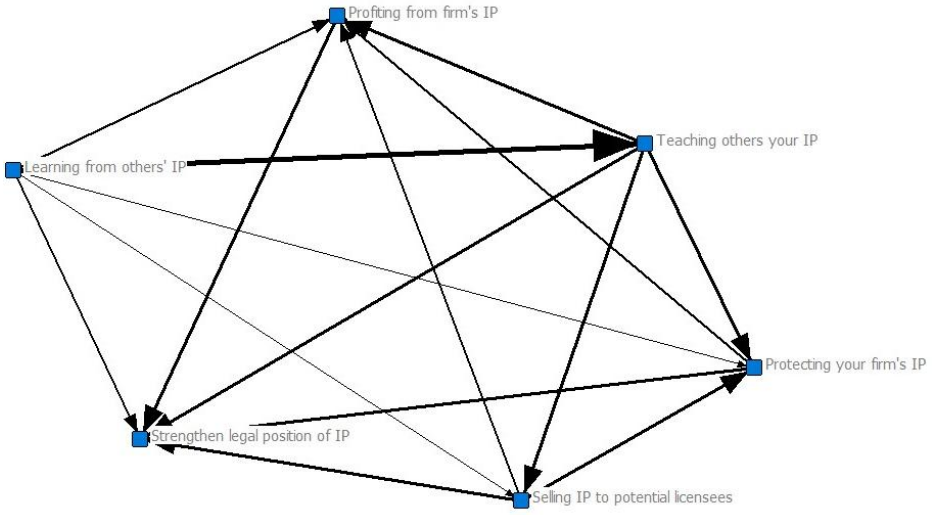

Figure 18: NetDraw Analysis of Question Six

Table 25 is an interpretation of the themes involves combining Step 2 with Step 3. While 'Teaching others your IP' has the highest centrality index (0.517), the key themes most directly related to the question (with inbound arrows) 'Strengthen Legal Position' and 'Profiting from Firm's IP' also have high centrality (0.415 and 0.406 respectively).

Table 25: Question Six Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 Learning from others IP	0.381
2 Teaching others your IP	0.517
3 Selling IP to Potential Customers	0.354
4 Protecting your Firms IP	0.345
5 Profiting from firm's IP	0.406
6 Strengthen Legal Position	0.415

Thus, it appears from the co-occurrence analysis, that the key, and more direct responses to the question, "Innovation advantage/IP sharing?" are 'Strengthen Legal

Position' and 'Profiting from Firm's IP', and that 'Teaching others your IP', while very important as a precursor theme, is still a more general, and less direct response to the question.

Question Eight: Generated six identifiable themes which appear below in a theme saliency input matrix.

	Large firms only	Maximum contacts	Potential licensees for IP	Potential suppliers	Synergistic partners	Potential customers for product
Large firms only		5	6	8	11	9
Maximum contacts			5	5	5	5
Potential licensees for IP				7	7	7
Potential suppliers					9	9
Synergistic partners						10
Potential customers for product						

For question eight, the 'NetDraw' program generated a visualisation of the thematic network (Figure 19 below). From this diagram the two themes having a majority of inbound arrows are 'Potential Customers for Products' and 'Synergistic Partners'. On the other hand, the themes 'Large Firms Only' and 'Maximum Contacts' and 'Potential Licensee for IP', with more outbound arrows, indicate themes with more distant connection to the question, and possibly indicate broader, precursor themes.

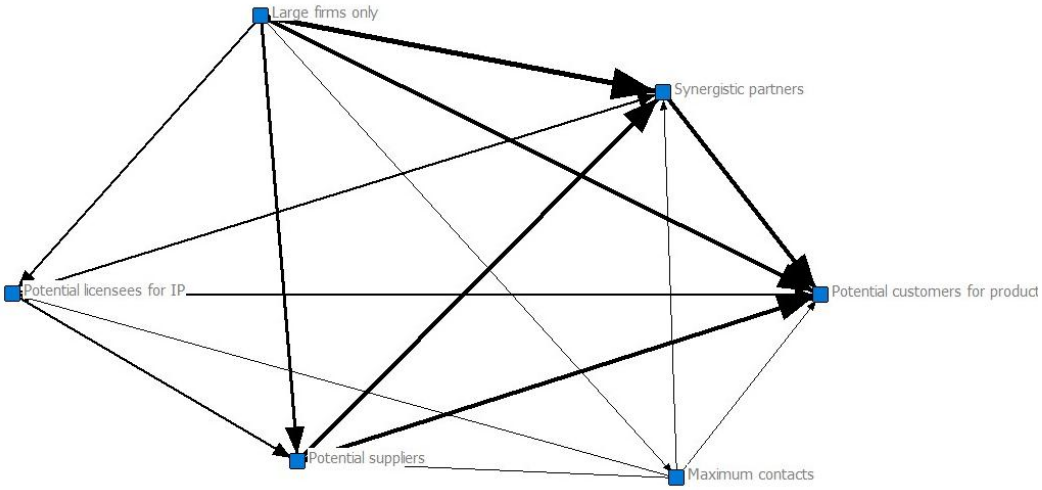

Figure 19: NetDraw Analysis of Question Eight

Table 26 combines Step 2 with Step 3. While 'Large Firms Only' has a high centrality index (0.437), the key themes most directly related to the question (with inbound arrows) 'Synergistic Partners' and 'Potential Customers for Products' also has high centrality (0.463 and 0.445 respectively). Thus it appears that the key themes, and more direct responses to the question, "Which company do you talk to most?" are

'Synergistic Partners' and 'Potential Customers', and that 'Large Firms', while important, is a more general, and less direct response to the question.

Table 26: Question Eight Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 Large Firms Only	**0.437**
2 Maximum contact	**0.289**
3 Potential Licensee for IP	**0.364**
4 Potential Suppliers	**0.425**
5 Synergistic Partners	**0.463**
6 Potential Customers for Products	**0.445**

Question Nine: Generated four identifiable themes which appear below in a theme saliency input matrix.

	BoD or large firms	smaller firms	Chairs of committees	Founding members
BoD or large firms		2	12	9
smaller firms			2	1
Chairs of committees				9
Founding members				

From the NetDraw diagram (Figure 20 on the following page) the two themes having a majority of inbound arrows are 'Founding Members' and 'Chairs of Committees'. However, the themes 'BoD or Large Firms' and 'Small Firms', with more outbound arrows, probably indicate broader, precursor themes.

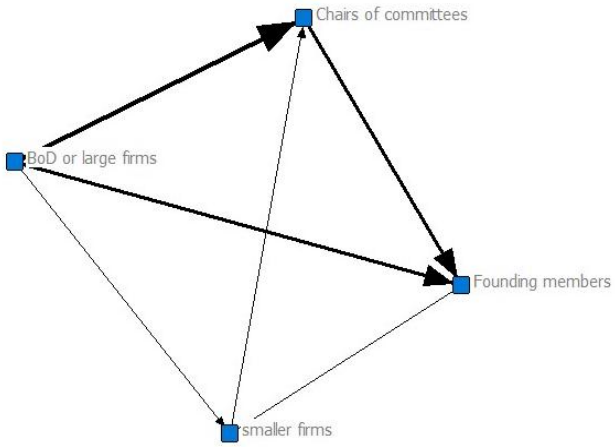

Figure 20: NetDraw Analysis of Question Nine

From Table 27, while 'BoD or Large Firms' have equal high centrality metrics (0.592), the key themes most directly related to the question (with inbound arrows) 'Founding Members' and 'Chairs of Committees' also have high centrality (0.527 and 0.592 respectively). Thus the key, and more direct responses to the question, "Which member of the A4WP is the most important?" appear to be the two themes of 'Founding Members' and 'Chairs of Committees'. The two themes, 'BoD or Large Firms', while important, appear as more general, and less direct responses to the question.

Table 27: Question Nine Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 BoD or Large Firms	**0.592**
2 Smaller Firms	**0.141**
3 Chairs of Committees	**0.592**
4 Founding Members	**0.527**

Question Thirteen: Generated five identifiable themes which appear below in a theme saliency input matrix.

	Larger firms	Board of Directors	Smaller firms	Companies with strong IP	Early members in standards org.
Larger firms		11	3	8	6
Board of Directors			2	6	5
Smaller firms				3	1
Companies with strong IP					4
Early members in standards org.					

From this, the 'NetDraw' program generated a visualisation of the thematic network (Figure 21). The two themes having a majority of inbound arrows are 'Early Members in Standard' and 'Companies with Strong IP'. This probably indicates these themes are most directly aligned to what question thirteen. On the other hand, the themes 'Larger Firms', 'BoD' and 'Smaller Firms' have more outbound arrows, thus indicating themes with more distant connection to the question.

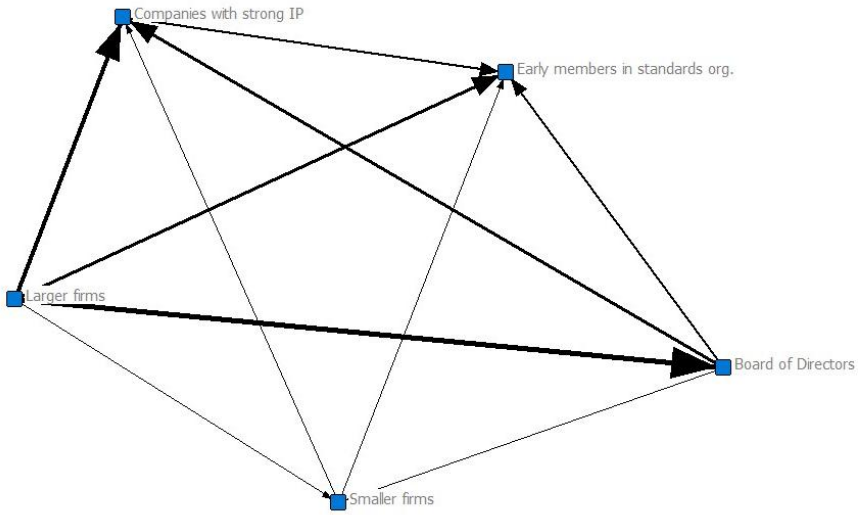

Figure 21: NetDraw Analysis of Question Thirteen

Table 28 combines Step 2 and Step 3. While 'Larger Firms' has the highest centrality index (0.572), the key themes most directly related to the question (with inbound arrows) 'Early Members' and 'Companies with Strong IP' also have high centrality (0.376 and 0.485 respectively). Thus, it can be concluded from the co-occurrence analysis, that the key, and more direct responses to the question, "Which member company will make the A4WP standard a success?" are 'Early Members' and 'Companies with Strong IP, and that 'Large Firms', while important, is a more general, and less direct response to the question.

Table 28: Question Thirteen Eigenvector Centrality Table

Theme Normalized Eigenvector Centrality (UCINET)	Low - High Importance
1 Large Firms	**0.572**
2 Smaller Firms	**0.210**
3 Board of Directors	**0.526**
4 Early members in standard	**0.376**
5 Companies with Strong IP	**0.485**

4.5.1 Empirical Results: The Cluster Analysis on Themes

While both the frequency and co-occurrence analyses provide important information about the importance of different themes, and the relationship between themes, they are both based upon a pooled analysis of the full sample. It could be that different firms are actually following different strategies and have different motivations when becoming involved in a standard setting alliance. A further analysis is required to see if this is the case.

As discussed in Chapter 3, a cluster analysis was used to determine the existence of different strategic behaviors, or strategy archtypes, used with respect to joining and participating in the A4WP. The input variables from the scores of themes identified from questions 1, 4, 5 and 6 were used in the cluster analsysis. These four questions were used since they appeared most relevant to identifying a firm's strategy, including benefit and risks, associated with joining and participating in the consortium.

The values used in the input matrix to the cluster analysis was a '2', if both coders agreed the theme was present in the interviewee's responses, a '1' if only one coder identified the theme as present, and a '0' if neither coder identified the presence of that theme. These values (0,1,2) represent the presence of a sub-themes for the four questions (1, 4, 5 and 6) were then entered into the cluster program (SPSS) to identify the common number of groups or clusters. The Wards clustering method was used (see

Chapter 3). A review of the resulting dendogram suggested a two cluster solution. As Forina et al. (2002) report, "the results of a clustering technique are generally reported in a plot (the dendrogram of similarities) where the ordinate is the similarity between groups" (Forina et al., 2002, p.13).

To interpret the clusters, the mean scores of each of the input variables (different themes for question 1, 4, 5 and 6) were examined for statistical differences. Table 29 below shows the thematic variables that had a statistically significant difference (t-test, prob<0.10 or higher) between the two clusters.

Table 29: Strategies for Joining Standards Consortium

Thematic Variable[1]	**Cluster One: 'Technology Prospectors'**	**Cluster Two: 'Technology Sellers'**
Q1c: Why member – IP positioning	1.22	0.36
Q1d: Why member – learning from other members' IP	1.44	0.45
Q1e: Why member – understanding early the technology standards	1.78	0.64
Q4f: Perceived risks – A4WP failing	1.33	0.45
Q5b: Membership Value – learning and influencing specs	1.67	0.91
Q6a: Innovation advantages – learning from others' IP	1.89	0.45
Q6b: Innovation advantages – teaching others our IP	2.00	1.18
Q6c: Innovation advantages – selling our IP to potential licensees	0.11	0.73
Q6d: Innovation advantages – protecting our company's IP	0.11	1.36
N (20 face to face interviews analysed)	9	11
Thematic variables with statistically significant mean differences (t-test, prob<0.10)		

Based upon the differences in the mean values for the statistically significant thematic variables, it was possible to provide an overall descriptive definition of the strategies or behaviours reflected in the two clusters. In addition, since it is possible to examine which firms were associated with the different clusters, additional information can be provided about the nature of the firm (including example quotes from the interview transcripts).

Behavioural Descriptors of the Two Clusters:

Cluster One: 'Technology Prospectors' was formed from the cluster of companies whose primary functions and strategy are similar. This cluster has much higher values on both IP and innovation themes, including learning about other's IP, and influencing IP standards. This suggests a more dynamic view of the technology, and that the strategy is to take advantage of the A4WP consortium for this reason. By examining the firms that ended up in this particular cluster, one of the main attribute of the members of this cluster is that they all manufacturer semiconductor devices individualised to specific markets. Examples of cluster one answers to the first question one (Why did you join the A4WP?), actual company name not disclosed. The following quotes are from different respondents.

"Since we are a chip designer we are interested to be part of it so we can from the beginning be part of that specification, definition".

"To get early information on how the standard is evolving so that it can influence your products early".

"Our strategy is to really look at the future of trends of the world's market, and we see that wireless charging is one of those trends. And we need to develop and be part of the industry. We need to be ready for what the market requirements are".

Others example for question four on the risks of failure: cluster one speaks of larger companies with more control and scale making the A4WP a success and the biggest risk is of the A4WP failing.

"Obviously you're investing a lot of time, energy, and resources in a standard that may end up going nowhere".

"So a risk would be if the standard didn't take hold, because we do depend on some of the larger companies to follow through, that we would have wasted time and resources".

"To gain technology information about what's in the market, how to do things, what the other people are working on".

Question five and six asks the value of membership to your products and innovation and IP advantages. The common theme of 'learning and influencing the standards specification' is widely mentioned by those in cluster one.

"Getting to work and collaborate with the major players in this industry and the chance of being part of the reference design and being introduced to other customers".

"It allows you early visibility into any standards errata that might be coming out and allows you to be one of the first of markets with the product once the standard is ratified".

"So it goes back to having access to the standard early, developing the standard, and if you can develop the standard you can make trade-offs in your favour that may or may not affect the performance of the product but would affect the development of the product".

"We have to gain more competencies in this first before to really see if we can offer some advantage to someone".

Cluster Two: 'Technology Sellers' scored higher on thematic variables related to a more static perspective of IP (or that these companies control the technology), and see the alliance as an opportunity for market prospecting Upon analysis the identified member companies selected for cluster two appear to have similar business models, practices or strategy. These companies practice common activities in promoting and marketing their Intellectual Property (IP). Qualcomm, Intel and Broadcom are the main companies of cluster two and these companies are amongst the largest and most dominate IP technology companies in the world. This common strategy of licensing and selling their IP provided the behavioural descriptor of 'Technology Sellers'.

Examples of this clusters answers to questions one "Why did you join the A4WP?" speak of the need to have their technology brought to market by others demonstrating

the theme of 'IP positioning**.** The following quotes are from different respondents from companies that fell in this cluster.

"We have technology that we'd like to bring to the marketplace, and it's an efficient way, ultimately, to find a large market".

"You need to enable other industry players to build that same technology".

The main difference in cluster two is visible in the interview answers for question five and six. The dominate themes are surrounding 'IP' by influencing the specification, teaching, selling and or protecting their Intellectual Property to make revenue.

"We've been working on the specification with the rest of the alliance members and we believe that our products – that we had intellectual property on – are part of that specification".

"It's trying to get the IP to become part of the DNA of a standard".

"We recognize that we need to be able to contribute a baseline level of IP that a standard can be built off on".

Table 30 shows the two clusters highlighting the different business models of the companies in each cluster. Cluster one is dominated with semiconductor manufacturers who seek market opportunities for their products. Cluster two is populated with IP focused organisations that sell their intellectual properties through licensing agreements.

Table 30: Types of Firms per Cluster (Appendix H details Two Clusters, n=9 and n=11)

Cluster One: "Technology Prospectors"	**Cluster Two: "Technology Sellers"**
Semi-Conductor Manufacturers seeking markets for products	IP Organizations that typically license IP

4.6 Expanded 'Graphical' Analysis of Companies (2014)

The final method to examine the process of how standard setting may be influenced by companies within a standard setting organisation is to examine the mapping of the various firms. While UCINET was used to estimate the specific measure of Freeman's Degree Centrality and Freeman's Betweenness measures, it can also be used in a graphical methodology to provide additional interpretation of how the A4WP firms are related to each other. I followed the graphical approach used in the Bar and Leiponen

(2014) study. Only the October, 2014 data is used for the graphical analysis since this time period is when the A4WP had 7 subcommittees, and was at its peak membership. This section complements the development of the primary, secondary, and tertiary measures used in the baseline regression analysis.

4.6.1 Primary Contact

As a final analysis, the interactions of the consortium's active members were mapped using the graphical techniques available in UCINET. While the total A4WP membership in 2014 was 137, only 50 firms were actively involved in the various sub-committees as of October 2014.

All active members were involved in the seven working committees.

1. Board of Directors
2. Test and Certification Committee
3. Regulatory Committee
4. Marketing Committee
5. Technical One <5W
6. Technical Two >5W
7. Resonator Committee

Each of the 50 members achieve primary contact status when involved in the same committee, if a member is active in more than one committee then it's possible to have multiple primary contacts with the same company.

Figure 22 on the next page maps all the seven committees as an overview and the following output from the NetDraw software program displaying in a graphical representation of the social network primary contacts or all seven committees.

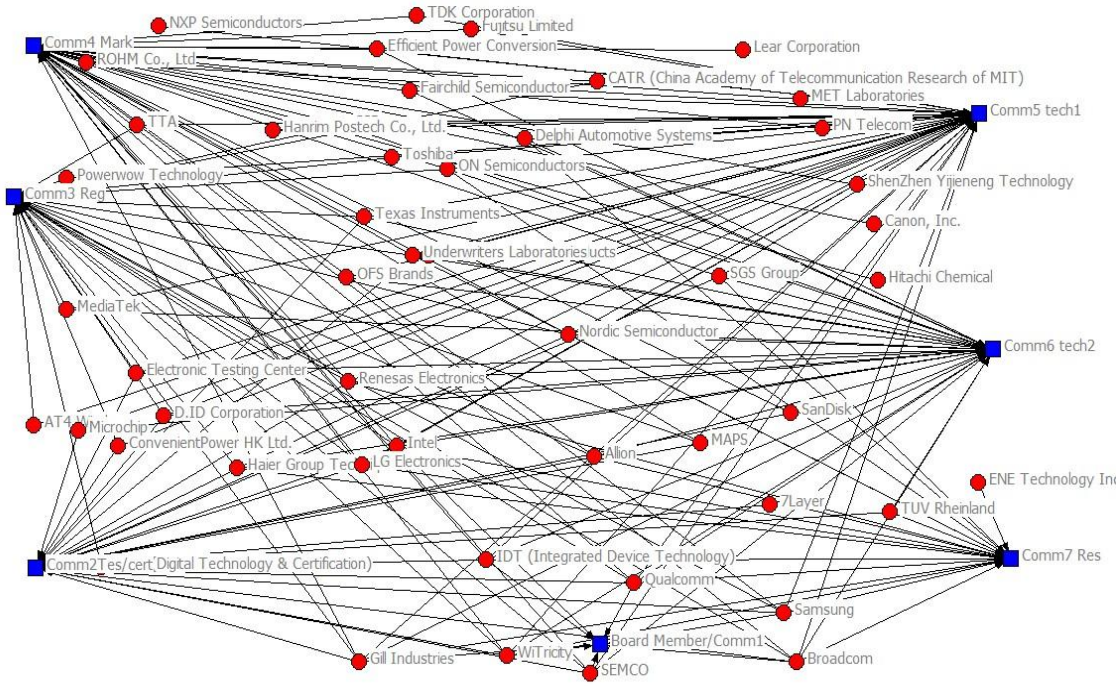

Figure 22: Seven Committees and 50 Active Members

Committee One, Board of Directors: The BoD contains eight sponsor members, of which three were founder members. The A4WP board members pay exactly the same joining and annual fees which allows for equal voting rights. The Board President is from Qualcomm (blue) and Vice President is from Samsung; these are elected positions.

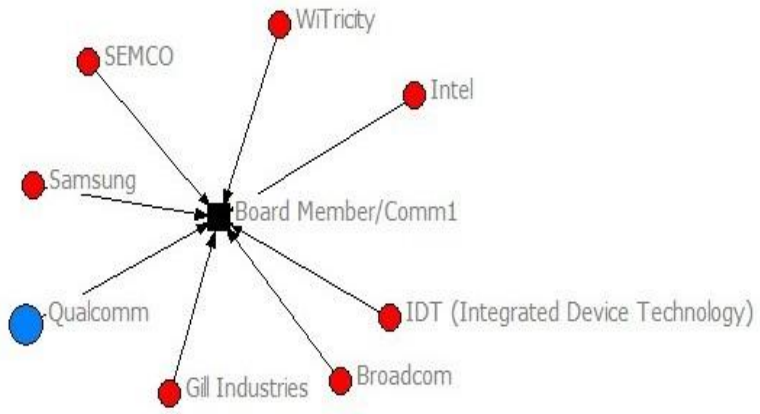

Figure 23: Board Committee Primary Contacts

Committee Two, Test/Certification: The committee has 24 primary contacts. The member fee is based on size and type. The committee chair is from Qualcomm (blue) and is an elected position. All the Board of Directors (Committee 1) are also members.

26 active member companies do not participate in this particular committee (list at left of diagram in green).

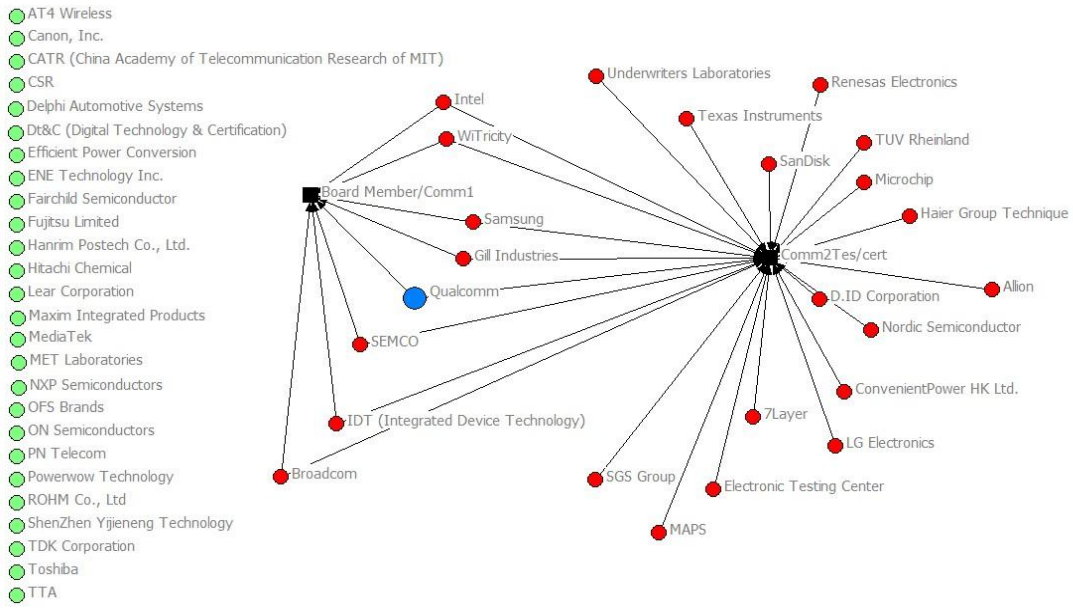

Figure 24: BoD and Test/Certification Committee Two

Committee Three, Regulatory: The committee has 27 primary contacts. The members' fee is based on size and type. The committee chair is from Intel and is an elected position (blue). All Board of Directors (Committee One) are members except IDT. 23 active member companies do not participate in this committee (green).

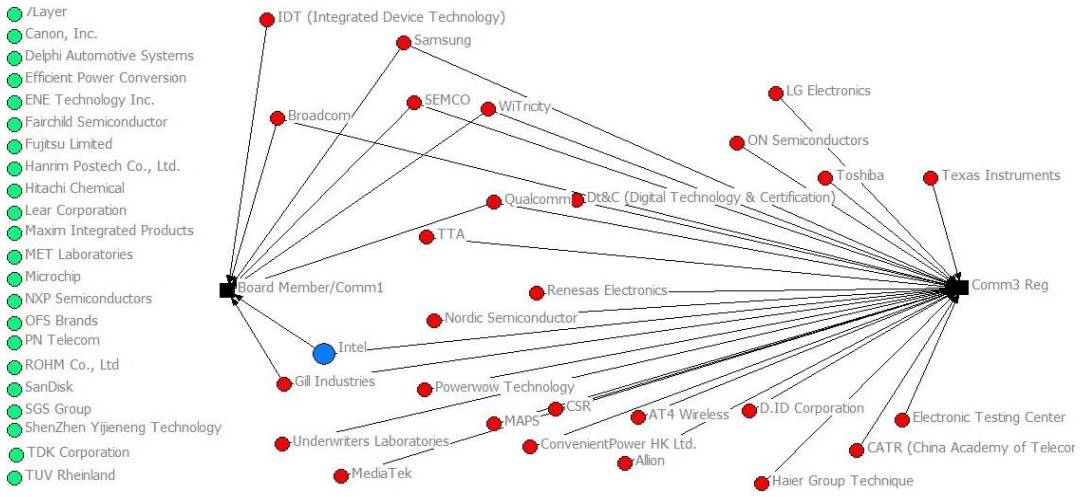

Figure 25: Regulatory/Compliance Committee Three

Committee Four, Marketing: The committee has 31 primary contacts. Similar to other working committees, the members' fee is based on size and type. The committee chair is from Qualcomm and is an elected position (blue). All Board of Directors (Committee One) are members. 19 of the active member companies do not participate in this committee (green).

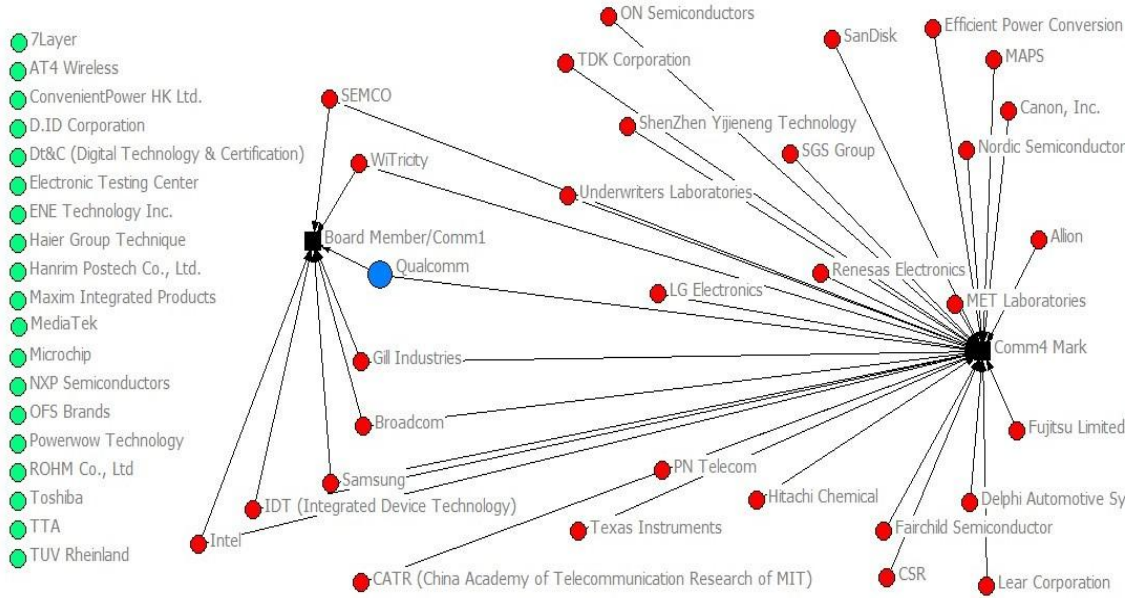

Figure 26: Marketing Committee Four

Committee Five, Technical One <5W: The committee has 36 primary contacts with the members fee is based on size and type.

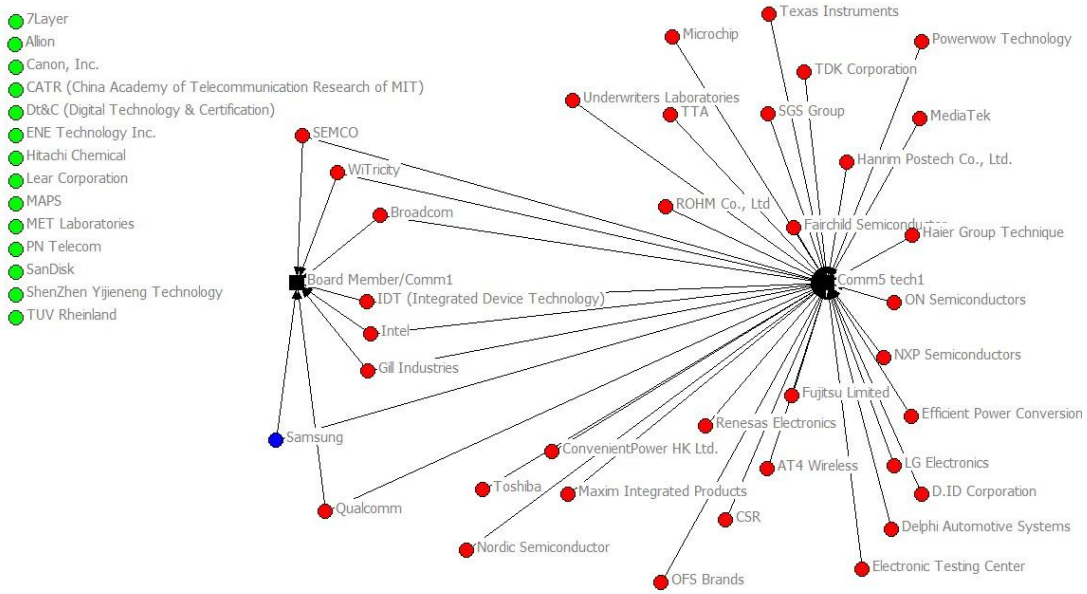

Figure 27: Technical Committee One <5W Five

The committee chair is from Samsung and is an elected position (blue). All Board of Directors (Committee One) are members. 14 active member companies do not participate in this committee (green).

Committee Six, Technical Two >5W: The committee has 26 primary contacts. The members' fee for this committee is also based on size and type. The committee chair is from Intel and is an elected position (blue). All Board of Directors (Committee One) are members except Samsung. 24 active member companies do not participate in this committee (green).

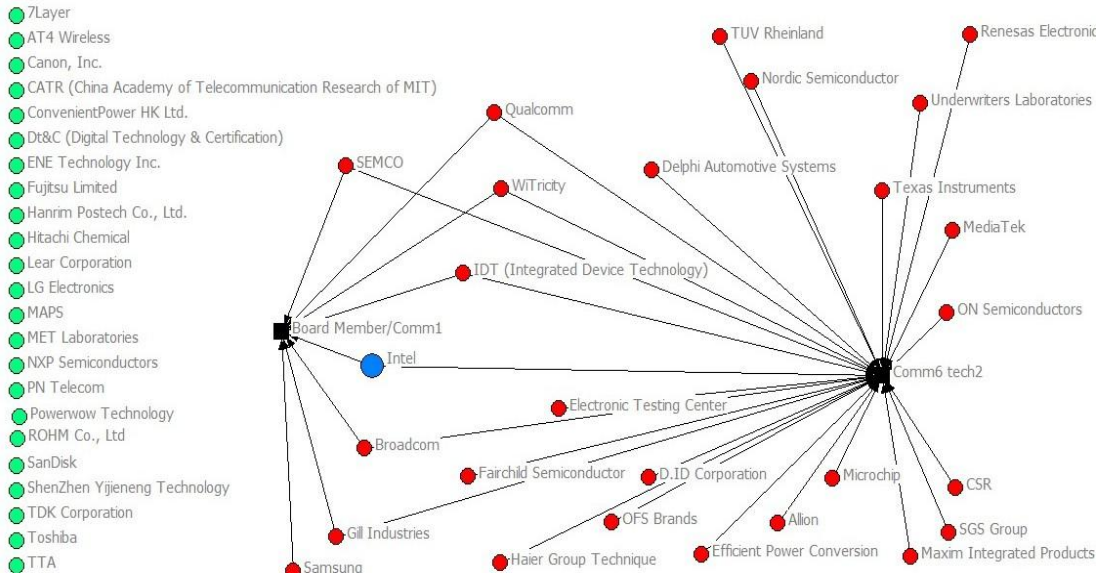

Figure 28: Technical Committee Two >5W Committee Six

Committee Seven, Resonator: The committee has 18 primary contacts with the members' fee determined by size and type. The 2014 committee chair is from Wi-Tricity and is an elected position (blue). All Board of Directors (Committee One) are members except one SEMCO. 32 active member companies do not participate in this committee (green). Figure 29 on the following page illustrated these connections.

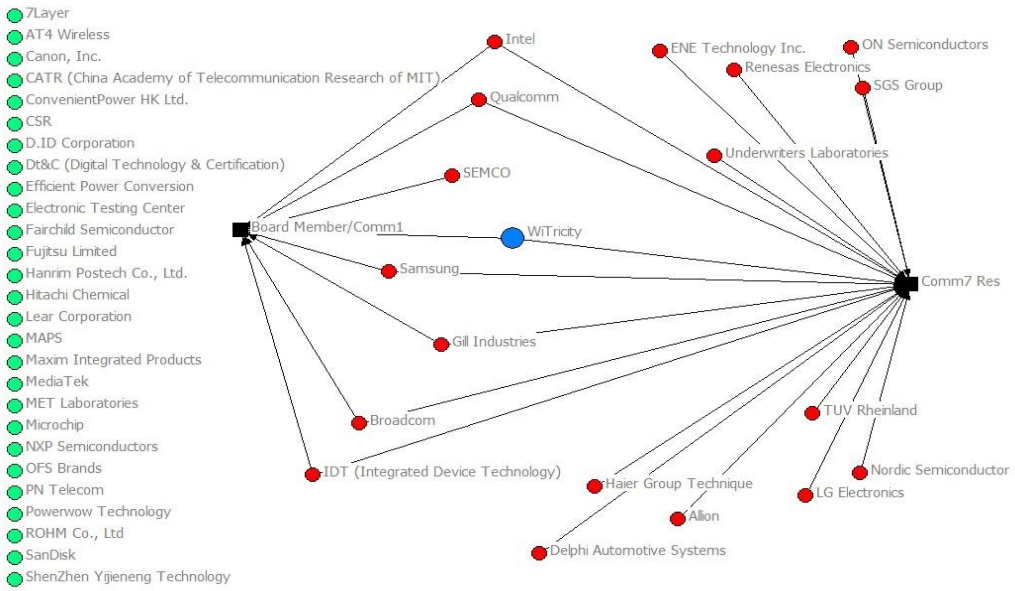

Figure 29: Resonator Committee Seven

4.6.2 Summary of Graphical Analysis Primary Committee Connections

Table 31 below shows all of the active members according to the number of primary contacts, as well as the members' fee and member category. Highlighted in yellow are the 14 companies that have leveraged themselves by gaining the highest amount of primary contacts (ranging from 131 to 163) based upon their committee membership.

Table 31: Number of Primary Contacts Per Supporter (Active) Member of A4WP

Name of Fifty 'supporter' Members	Number of Primary Contacts	Company Size/Fee Fee 0: free, 1:$2.5k, 2:$4.5k, 3: $12.5k, 4: $25k, 5: $50k	Member Category 1) sponsor (BoD), 2) Large, 3)Medium, 4)Small, 5) Test, 6) Adopter 7)other
Broadcom, Gill Industries, Intel, Qualcomm, Wi-Tricity	163	5	1
Nordic Semiconductor, Renesas	156	4	2
Underwriters Laboratories	156	1	5
Semco	146	5	1
Texas Instruments	139	4	2
ON Semiconductors	138	4	2
Samsung	137	5	1

LG Electronics	133	4	2
IDT (Integrated Device Technology)	131	5	1
SGS Group	130	1	5
Haier Group Technique	126	4	2
Allion	121	1	5
CSR	116	4	2
D.ID Corporation	109	1	6
Electronic Testing Center	109	1	5
Delphi Automotive Systems	107	4	2
Efficient Power Conversion	90	2	4
Fairchild Semiconductor	90	1	6
MediaTek	86	4	2
ConvenientPower HK Ltd.	84	2	4
Microchip	83	1	6
MAPS	79	2	4
Fujitsu Limited	65	4	2
TDK Corporation	65	2	4
TUV Rheinland	65	1	5
AT4 Wireless	61	1	5
Powerwow Technology	61	2	4
Toshiba	61	4	2
TTA	61	1	5
Maxim Integrated Products	60	1	6
OFS Brands	60	1	6
CATR (China Academy of Telecommunication Research of MIT)	56	1	6
SanDisk	53	4	2
Hanrim Postech Co., Ltd.	35	3	3

NXP Semiconductors	35	1	6
ROHM Co., Ltd	35	4	2
Canon, Inc.	30	4	2
Hitachi Chemical	30	4	2
Lear Corporation	30	1	6
MET Laboratories	30	1	5
PN Telecom	30	1	6
ShenZhen Yijieneng Technology	30	2	4
DtandC (Digital Technology and Certification)	26	1	5
7Layer	23	1	5
ENE Technology Inc.	17	1	6

The graphical analysis in this section supports the findings from the previous regressions that found that Freeman's Degree Centrality was positively related to introduction of standard proposals. The fourteen members highlighted in yellow above are clearly the most dominant in actively proposing of committee work items, and are responsible for 94% or 97 of the work items successfully proposed and voted on in 2014. These active members are in positions to control the vast majority of policy output from the A4WP standards alliance. The data indicates a strong correlation between the number of primary contacts and standards setting within the A4WP.

4.6.3 Secondary and Tertiary Contacts

'Secondary contacts' are formed as a result of a common link of membership category or application while 'tertiary contacts' share A4WP membership as the source of similarity. Member companies who have no primary contact will still have secondary and tertiary contacts. If a member company has no primary contacts then the number of secondary contacts plus the number of tertiary contacts will always add up to 137 which is the total membership as of October 2014. Table 32 on the next page shows the 'inactive' firms that have no primary contacts as described above, but still have secondary and tertiary contacts. Example Avnet have zero primary contacts but has 78 secondary and 59 tertiary contacts, total 137.

Table 32: List of All Secondary and Tertiary Contacts Only (No Primary)

	Member Company Name	Primary Contacts	Secondary Contacts	Tertiary Contacts	Total Members
1.	AAC Technologies	0	78	59	137
2.	Acer	0	78	59	137
3.	Active-Semi Inc.	0	78	59	137
4.	Airoha	0	78	59	137
5.	Alps Electric	0	78	59	137
6.	Amphenol Finland Oy	0	78	59	137
7.	Avnet	0	78	59	137
8.	Beijing CET Power	0	78	59	137
9.	BandT Enterprise Ltd.	0	78	59	137
10.	BYD (Huizhou) Co. Ltd.	0	78	59	137
11.	CCA Designing and Manufacturing	0	78	59	137
12.	Chemtronics	0	78	59	137
13.	Daedong	0	78	59	137
14.	Denso Corporation	0	78	59	137
15.	Deutsche Telekom	0	78	59	137
16.	Dialog Semiconductor	0	78	59	137
17.	Diodes Incorporated	0	78	59	137
18.	DuPont Building Innovations	0	78	59	137
19.	EandE Magnetics Products	0	78	59	137
20.	Elentec	0	78	59	137
21.	Ever Win International	0	78	59	137
22.	Frontline Test Equipment	0	78	59	137
23.	Funai Electric	0	78	59	137
24.	Godsword Tech	0	78	59	137
25.	Heesung Electronics	0	78	59	137
26.	Hon Hai Precision Ind. Co., Ltd. (Foxconn)	0	78	59	137

27.	Hosiden Corporation	0	78	59	137
28.	HST Tech Co., Ltd.	0	78	59	137
29.	HTC Corporation	0	78	59	137
30.	iCirround	0	78	59	137
31.	IPAN IPAN	0	78	59	137
32.	jjPlus Corp	0	78	59	137
33.	KDDI	0	78	59	137
34.	Kokuyo Furniture Co., Ltd.	0	78	59	137
35.	Legrand	0	78	59	137
36.	Lenovo	0	78	59	137
37.	Logitech	0	78	59	137
38.	Mantaro Product Development Services	0	78	59	137
39.	Marvell	0	78	59	137
40.	Microtips Technology	0	78	59	137
41.	Murata	0	78	59	137
42.	NEC TOKIN Corporation	0	78	59	137
43.	Novero	0	78	59	137
44.	Omron Automotive Electronics	0	78	59	137
45.	Panasonic	0	78	59	137
46.	Pantech	0	78	59	137
47.	Paragon AG	0	78	59	137
48.	Pegatron Corporation	0	78	59	137
49.	Primax Electronics	0	78	59	137
50.	Quintic Corporation	0	78	59	137
51.	Redpine Signals	0	78	59	137
52.	RFTech	0	78	59	137
53.	Richtek	0	78	59	137
54.	SHARP Corporation	0	78	59	137

55.	SK Telecom	0	78	59	137
56.	Sony Mobile Communications	0	78	59	137
57.	SNPowercom	0	78	59	137
58.	Sumitomo Electric Printed Circuits	0	78	59	137
59.	Sunlord Electronics	0	78	59	137
60.	Targus, Inc.	0	78	59	137
61.	Techrein Co., Ltd.	0	78	59	137
62.	Tektos Limited	0	78	59	137
63.	TennRich International	0	78	59	137
64.	TODAISU	0	78	59	137
65.	Triune Systems	0	78	59	137
66.	Visteon Corporation	0	78	59	137
67.	WiSilica	0	78	59	137
68.	Wurth Elektronik	0	78	59	137
69.	Wuxi China Resources Semico Co., Ltd.	0	78	59	137
70.	Asustek Computer Inc.	0	18	119	137
71.	Dell Corporation	0	18	119	137
72.	Hewlett Packard	0	18	119	137
73.	Otterbox	0	18	119	137
74.	Cetecom	0	13	124	137
75.	Comarch, Inc.	0	13	124	137
76.	Ellisys	0	13	124	137
77.	Shenzhen Hello Tech Energy Co., Ltd.	0	13	124	137
78.	Amotech	0	8	129	137
79.	Shenzhen Xuze Technology Co., Ltd.	0	8	129	137
80.	SPACON	0	8	129	137
81.	Denso International of America	0	4	133	137
82.	EBO Cambridge	0	4	133	137

83.	Emirates	0	4	133	137
84.	KETI	0	4	133	137
85.	LG Innotek	0	4	133	137
86.	Chargifi	0	2	135	137
87.	Peiker Acustic GmbH and Co.	0	2	135	137

Leveraging Secondary contacts may occur outside the A4WP environment, secondary contacts could interact within industry and application events (i.e., membership of common industry association). Tertiary contact is gained by being a member of the A4WP and sharing contacts from the member's database, tertiary members may leverage joint membership contact with A4WP members.

The regression analysis in the quantitative section of the study found Secondary and Tertiary contacts as non-significant in predicting influence within the A4WP. This social network analysis proportion of this current research also finds these contacts as non-significant. All activity and companies that seek to gain influence within this standards-base alliance depend of being an active member. As a result of active membership Primary contacts are enabled.

4.7 Summary

The chapter sought to process the details of the data gathered in this current research and analysed using both quantitative and qualitative tools.

Qualitative Methods:

The analysis of the qualitative data gathered from the interviews complemented the quantitative regressions and SNA analyses as they both focused on testing the stated hypotheses and research questions. Several different methods were used in this analysis, including a thematic co-occurrence analysis and a cluster analysis of themes. The qualitative data supported in general the quantitative results and provided additional findings regarding attitudes to risk, committees and large companies. The qualitative analysis also identified two basic strategies that companies see in joining a standard setting alliance, technology prospecting and technology selling.

Quantitative Methods:

The first step in the quantitative analysis examined three baseline hypotheses similar to prior research about standard setting organisation influence. Our regressions were able to produce significant results of the importance of the independent variables used to gain influence, and lends support to the Bar and Leiponen (2014) findings. Additionally, this research recreated the Degree Centrality test performed by Dokko and Rosenkopf (2010). In addition, the expansive nature of the A4WP member categories and data collected aided the addition of four new hypotheses that were tested using a variety of regressions on both the full data and the 'active' members.

A Social Network Analysis (SNA) of all member interactions was performed using UCINET software. This identified the primary connections achieved by the 50 active members within each of the seven committees (Figures 23-29).

Table 33 below compares both the quantitative and qualitative regression results with each of the seven hypotheses listing if the qualitative (interview) results support the regression results and the reasons found.

Table 33: Comparison of Results

Hypothesis	Regression Results	Qualitative Analysis Support
H1: A firm's intellectual property (IP) portfolios (patent stock) are positively related to standard-setting influence.	**H1 Accepted**	**Interview results support the regression results:** IP appears to be leveraged by BoD members and committee member's activity.
H2: Centrality in the alliance network is positively related to standard-setting influence.	**H2 Accepted**	**Interview results support the regression results:** The dominant theme to the data is the importance of an ecosystem in building a standard to increase/enable market adoption. Member's interactions and connections with fellow members were cited as an activity performed by each interviewed company. These activities support the Dokko and Rosenkopf (2010) centrality test over the 3 year period.
H3: Company size is positively related to standard-setting influence.	**H3 Accepted**	**Interview results support the regression results:** All BoD members and committee chairs are large companies (only: Wi-Tricity is not).

H4: Network Betweenness in the alliance network is positively related to standard-setting influence.	**H4 Accepted**	**Interview results support the regression results:** Gaining member connections and achieving influence is significant.
H5: Alliance tenure is positively related to standard-setting influence.	**H5 Accepted**	**Interview results don't support the regression results:** Year joined is Non-significant (Intel and Wi-Tricity joined late but secured high responses in interviews.
H6. Committee "chairmanship" is positively related to standard-setting in influence.	**H6 Accepted**	**Interview results support the regression results:** Committee Chairs appear to be in a prime position to capitalize on connections and influence.
H7: Technical committee membership is positively related to standard-setting in influence.	**H7 Not Accepted**:	**Interview results support the regression results:** Does the activity performed by the committee have different effects on the influence leveraged by each active member.

The next chapter is the conclusion and summary section and identifies the results of the research analysis.

5. Chapter Five: Conclusion and Summary

5.1 Introduction

The research title of this research, 'Investigating the Value of Formal Alliances and Competitor Interdependency in the Development of Consumer Technology Standards' and was the focus of all the components of work carried out. The previous chapter described the results of the various types of tests and analyses on data gathered from the A4WP member website, committee meeting minutes and reports, and the additional face-to-face interview material. This chapter provides the conclusion and summary of this current research results by comparing both the quantitative and qualitative results in addressing the research hypotheses, objectives and questions from chapters two and four. This chapter also illustrates additional information of contributions, limitations of the study, and proposal of further research.

The details of Chapter 5 is as follows

1. Baseline Results for First Three Hypotheses
2. Results for the Four New Hypotheses
3. Comparison of Quantitative and Qualitative Results per Seven Hypotheses
4. Results of Research Objective
5. Results of Research the Two Research Questions
6. Academic Research Contribution
7. Professional Standards-based Alliance Contribution
8. Identified Research Limitations
9. Suggested Additional Research Subjects
10. Conclusion Summary

5.2 Summary Results of Quantitative and Qualitative Testing of Hypotheses

The first three hypotheses tested were similar to that of the baseline work from Bar and Leiponen (2014), which addressed the impact of IP, primary, secondary, and tertiary contact activity and company size on influence within a standard setting alliance. An additional four hypotheses regarding total amount of connection points, year joined A4WP, committee chair positions and committee activity performed were also examined in the present study.

Both the quantitative and qualitative tests of all the seven hypothesis results are listed below.

H1: A firm's intellectual property (IP) portfolios (patent stock) are positively related to standard-setting influence.

H1-Quantitative Analysis: This was examined during the baseline testing of A4WP Membership Data Regression Analysis (similar to Bar and Leiponen, 2014). For H1, in the majority of the baseline models tested using the A4WP data, the IP technology variables are in the hypothesised direction and statistically significant. This is true for both the Euclidean measure if IP and the USPTO IP count measure. A firm's intellectual property position appears to be positively and significantly related to the technology standard setting process. In the full model regressions, all of the models had at least one of estimated coefficients on the IP variables, and usually both IP variables, statistically significantly and positively related to the technology standard influence.

The conclusion of the quantitative analysis is that H1 is accepted

H1-Qualitative Analysis: Interview question six asked specifically if membership in the A4WP would assist in leveraging company IP, 80% of the responses stated that IP leveraging was a key factor/activity of membership (Table 20).

The thematic analysis of the 20 interview transcripts identified 41 individual themes of which over half were directly related to discussion on IP placement, selling, sharing and learning (Table 17). The results of the eigenvalue centrality testing in the thematic co-occurrence analysis resulted in IP being highly significant in all the answers analysed for questions either directly or indirectly related to IP. IP infringement was the highest identified risk in question four's eigenvector test for perceived risks (Table 23).

With respect to the cluster analysis of themes, of the two identified clusters, cluster two is specifically centred on IP with the behavioural descriptor of 'Technology Sellers' (Table 30). This cluster had over half of the interviewed member company with a primary business model, practices and strategies centred on IP placement, licensing and revenue generation. This cluster of members appear as a dominate sub-section as the three main corporations all hold Board of Directors positions within the A4WP.

The conclusion of the qualitative analysis supports the quantitative regression analysis that H1 is accepted.

H2: Centrality in the alliance network is positively related to standard-setting influence.

H2-Quantitative Analysis: This hypothesis was examined during the baseline testing of the A4WP membership data using regression Analysis (similar to Bar and Leiponen, 2014, Table 10). In the majority of the baseline models tested, the Bar and Leiponen (2014) measure of Primary contacts was statistically significant and in the hypothesised direction. Secondary and Tertiary contacts did not appear to be significantly related to influence. Likewise, in all of the baseline models that used the Freeman's Degree Centrality measure (following Dokko and Rosenkopf, 2010), the centrality variable was statistically significant and in the hypothesised direction (Table 12). Similarity, in the vast majority of the full model regressions, both the Freeman's Degree Centrality and the Primary Contact measure was statistically significant and in the hypothesised direction.

The conclusion of the quantitative analysis is that H2 is accepted

H2-Qualitative Analysis: The interviews addressed the importance of the committee output and whether active members can leverage their companies into a position of influence. The most common answer to interview question one - why be a member? - was being active in building the A4WP standard to increase/enable market adoption.

Also, the committee membership data of the fifty active members demonstrated clear strategies exercised to gain primary member contacts. From Table 26, the thematic content analysis found that the themes, 'Synergistic Partners' and 'Potential Customers for Products' had the highest member connections.

Table 31 presented the number of primary contacts achieved by each active member. From the fifty active committee members the most highly active companies achieved 163 contacts. This was identified as a key method of leveraging influence in the committee's contribution to the A4WP standards with 94% or 97 of the work items successfully proposed and voted on in 2014.

With respect to the cluster analysis of themes, a common theme of both cluster one and two was that members speak of gaining information, or gaining influence, that contributes to both clusters business models (section 4.5.1.). Examples of cluster member's statements in the interview transcripts support that active membership contributes to their business strategy. For example, a cluster one member stated, "It allows you early visibility into any standards errata that might be coming out". A cluster two member stated that by being an active member "It's trying to get the IP to become part of the DNA of a standard".

The conclusion of the qualitative data supports the quantitative regression analysis that H2 central and connected members can influence standards is accepted.

H3: Centrality in the alliance network is positively related to standard-setting influence.

H3-Quantitative Analysis: In all baseline models tested, the revenue size variable was statistically significant and in the hypothesised direction. In the majority of the full model regressions, the revenue variable remained statistically significant and in the hypothesised direction.

The conclusion of the quantitative regression is that H3 for company size contributing to influence within the A4WP is accepted.

H3-Qualitative Analysis: The interview and membership minutes data demonstrates that company size does play a factor in the perception of influence to other members. All but one of the Board member companies are large (Wi-Tricity is not). The interviewees all stated large companies' leverage as having the most influence. Many stated they joined so they can be part of the ecosystem with the larger organisations, as expressed by one interviewee: "build relationships at the technology level that sometimes can help the product".

For both question eight 'who do you talk to most?' and question nine 'who is the most important?' the most common answer was 'Board of Directors and large companies' with 65% of the interviewees mentioning that larger companies have the greater interactions and importance. Table 20 highlights that the greatest percentage themed answers for questions 8, 9 and 13 were all 'Large Company' focused with frequency percentages of >65%.

The importance of large members was clear in the thematic eigenvector centrality test in question nine 'who is the most important' (Table 27). The 0.592 eigenvalue centrality metric for 'Large Firms' is almost four times the eigenvalue results for 'Small Companies' which was calculated as 0.141.

The conclusion of the qualitative analysis supports the regression analysis that H3 is accepted.

A4WP Member Additional Data Gathered and Processed: As previously mentioned, the database from the A4WP offered the opportunity to examine information over and above the data collected from Bar and Leiponen (2014). Also, the research measured centrality similar to Dokko and Rosenkopf (2010). These additional elements led to the creation of four additional hypotheses that were tested using the hierarchical regression method in Chapter 4.

Additional Hypotheses:

H4: Network Betweenness in the alliance network is positively related to standard-setting influence.

H4-Quantitative Analysis: Betweenness measures indicated how much a node within a network is used to join other nodes within the network via the shortest path. This was examined by the Freeman's Betweenness Centrality measure introduced in the full model specification. In seven out of ten of the estimated full model regressions, the Freeman's Betweenness is statistically significant and in the hypothesised direction.

The conclusion of the quantitative analysis is that H4 is accepted

H4-Qualitative Analysis: The interview and membership minute data demonstrates that member activity in the committees is significant. The supporter or 'active' category of members who propose committee work items is mentioned in every discussion on influence and the qualitative data highlights that every committee was mentioned as being powerful in gaining influence. Key themes identified from the interviews were 'learning from others' and 'direct placement of your product within standards spec'. These actions were achieved by mixing and contacting with other companies in committees in 'creating a market to adopt your products' (95% in Q5 Table 20).

Table 31 presents the highest amount of connections gained from the most active member direct contacts gained as 131-163. There were 14 extremely active members that gained over 131 direct contacts from the database of 50 active members.

The conclusion supports the regression analysis that H4 is accepted.

H5: Alliance tenure is positively related to standard-setting influence.

This hypothesis concerns whether the earlier a member firm joins assists in gaining of influence within the standards organisation, or is the time of joining not important to the member's ability in gaining influence.

H5-Quantitative Analysis: This was also examined in the full model specification. The Tenure variable is statistically significant (<0.05 significance levels) and in the hypothesised direction in all of the estimated regression models.

The conclusion of the quantitative regressions is that the H5 is accepted.

H5-Qualitative Analysis: The interview and membership minute data demonstrates that the key early member's presence is extremely strong, and in particular, for Qualcomm and Samsung. However, early board members SEMCO, Gill Industries, and IDT do not measure as highly. Three key board members joined much later (Intel, Wi-Tricity and Broadcom) and they all have managed to gain leverage and influence by being elected chairs of different committees.

During the analysis of question nine, one theme identified from the coding of the interview transcripts was 'Founding Member'; a theme that is associated to H5 as it relates to length of tenure in the A4WP (Table 20). The analysis of the proximity input matrix presented this as the most significant theme to the question as indicated by the eigenvector measure in Table 27. It is interesting to note that this differed from the previous code frequency analysis in Table 20 which resulted in a lower significance measure of 45%.

This result that early members don't have an advantage was also found in the literature review section earlier when Wang et al. (2010) and Murray et al. (2012) stated that their results demonstrated the early adopter advantage weakens with the arrival of more member companies.

The conclusion of the qualitative analysis differs slightly to the quantitative regression analysis and therefore doesn't clearly support or rejects H5.

H6: Being a committee chair increases the influence a member firm can achieve on the standards organisation.

This hypothesis examines whether positions of perceived power within the seven committees to see if there is actual control or standard setting influence from the chair (leadership) position.

H6-Quantitative Analysis: Being one of the seven committee chair positions was tested during the full model specification. In five of the estimated full model equations, Committee Chair is statistically significant and in the hypothesised direction. However, in two of the models, Committee Chair is statistically significant but opposite from the hypothesised direction. Taken together, it appears that the hypothesis is supported.

The conclusion of the quantitative analysis is that H6 is accepted.

H6-Qualitative Analysis: The interviewees were not asked directly if being committee chair leverages influence; however, interview question nine asked which member companies were interacted with most, and all companies named were committee chair companies. Question nine also asked about which companies were the most important member companies, and 65% of the respondents mentioned the key theme of committee chair companies Table 20. Committee chairs were also identified as a key centrality factor as shown in Table 27.

The conclusion of the qualitative analysis supports the quantitative regression so H6 is accepted.

H7: Technical committee membership is positively related to standard-setting in influence.

The A4WP data had seven committee types (one being the Board of Directors). It was felt that two committees, Certification/Test and Regulation, were the most critical in terms of the overall standard setting process since these committees were in existence for the full three-year period (2012-2014) under investigation. Membership in these two committees was examined with respect to hypothesis seven.

H7-Quantitative Analysis: This was tested in the full model specification by membership in these two important working committees that result in technology standards, the Certification and Testing committee, and the Regulation committee. However, membership in the two subcommittees had statistical significance in only one of the estimated regression models.

The conclusion of the quantitative analysis is that H7 is not accepted.

H7-Qualitative Analysis: The interviewees discussed a prominent committee's directly during question twelve 'Which committee is the most important'. From the twenty transcripts all of the seven working committees were mentioned by name, however the most mentioned beyond the Board of Directors were the various 'technical' focused committees. These technical committees gave active members the opportunity to influence 'technical specifications' and also 'understanding early the technical specs to suit own company' (see Table 20).

The conclusion of the qualitative analysis differs slightly to the quantitative regression analysis and therefore doesn't clearly support or rejects H7.

5.2.1 Summary of Section 10.2

The above summary of Chapter 4 provides results for all seven hypotheses (three baseline hypotheses and four additional hypotheses). The quantitative regression components of the analysis results in that six of the hypotheses were accepted, with only H7 not accepted. The qualitative results largely supported the regression results, only differing on the results of H5.

The number of hypotheses tested in this current research certainly was greater than the baseline work by Bar and Leiponen (2014). The research certainly benefited from the addition of the new four hypotheses tested in the full model specification in Chapter 4. Figure 30 on the following page illustrates the results create a clearer picture of the member behaviour of large companies leveraging IP by actively leading and networking within the committees.

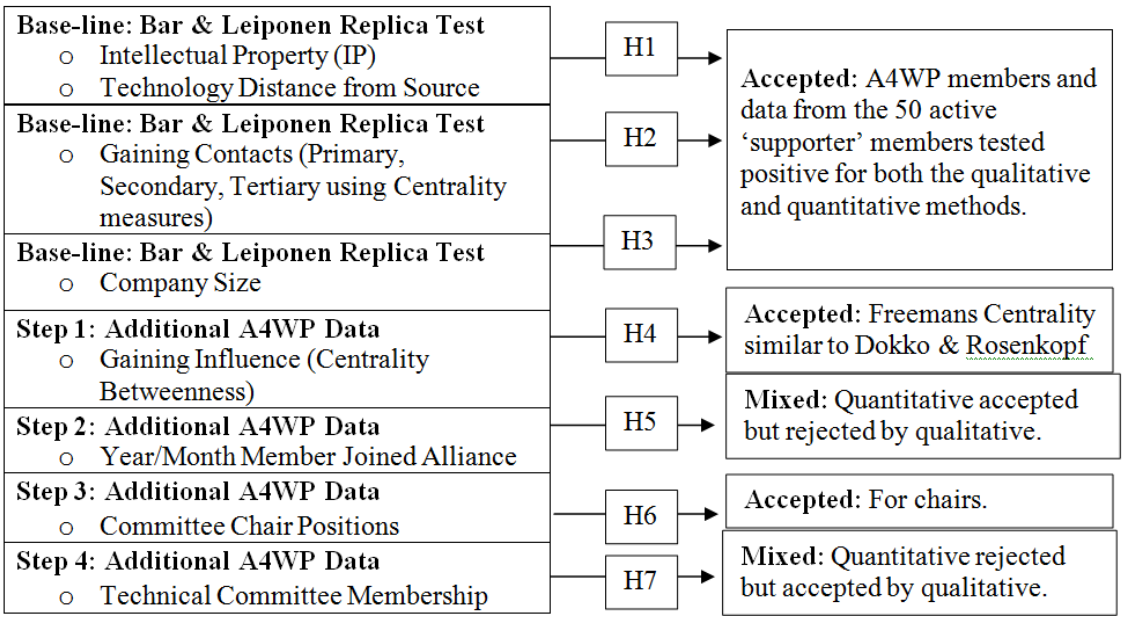

Figure 30: Regression and Qualitative Hypothesis Results

These seven hypotheses were examined using both an in-depth quantitative analysis and multiple qualitative methods, including a thematic co-occurrence analysis. The research results illustrate the preferred methods and behaviour to gain influence favouring large member companies with strong IP positions, maxim member contacts that chair committees within a standards-based alliance.

Taken together, the results present a robust representation of the A4WP membership database and members influence within an important standard setting alliance for an emerging technology, wireless power.

5.3 Summary Results of Research Objectives and Questions

5.3.1 Results of Research Objectives

Chapter one stated there were three objectives of the current research in identifying and understanding the following traits of the member companies with the A4WP alliance.

1) ***The business strategy for co-operation with competitors in standards organisations.***

Summary Conclusion: Interview question one produced valuable insight into this point. The executives expressed a key interest in building and being part of an ecosystem that enabled them as members to bring their own product to market (faster and cheaper). Two prominent themes with over 90% frequency from the interview

transcripts were ‘direct placement of your product within standards spec’ and ‘creating a market to adopt your products’, (Table 20), these two popular themes speak to the strategy of why co-operate with competitors with the A4WP. All subjects interviewed expressed that a standards body was an efficient method of providing the industry the technology standards to follow. Some expressed an interest in receiving and or influencing these standards early so to keep their own product ahead. Over half the member companies interviewed stated there is a formal policy within their organisation addressing dialogue when co-operating with competitors during standards association interactions.

The cluster analysis on themes also presented insight. Two different generic strategies appear dominant, one representing firms prospecting for technology, and the other for firms selling their technology.

An finally, the centrality calculations clearly indicated that some firms consistently held high centrality positions through their membership involvement, and that the regression analysis indicated that this centrality was associated with influence.

2) ***The amount of necessary member activity in the seven committees of the A4WP wireless power standard.***

Summary Conclusion: The analysis provided the clearest understanding for the amount of activity. The total membership at the time of data sampling in 2014 was 137 member companies of which 50 companies were active in the seven committees (proposing, voting, attending meetings, events, information sharing and engagement in developing technical standards). Interview question seventeen asked about the amount of time each executive gave to A4WP activity, and committee members/chairs stated upwards of fifty percent of their job, with many stating it a fulltime endeavour. During the analysis of Figures 6-12 its shows 68% of members actively participating in multiple committee’s with only less than a third of the active members supporting a single committee.

The summary of objective two is that the amount of member activity necessary is considerable for the fully active and successful/influential members.

3) ***The attitudes and behaviour of the selected executives in leveraging their company’s standards membership for commercial market gain.***

Summary Conclusion: The interview transcripts covering the objective were analysed, and the data collected indicated both personal satisfaction and professional advantages of being part of the A4WP. One interviewee stated, "I think it gives me a lot of insight in what's going on in the industry". When asked their attitude toward risk, 40% of the respondents said they were aware and prepared for interactions with competition and did not see any risk by being closely involved with their competitors. Fifty percent of those questioned received formal training for dealing with competition, and only the smaller organisations were concerned about dealing with the larger member companies. Three of the key behaviours of members were identified in the analysis of the themes (all scoring 95% and above) of those questioned stated that they are 'creating a market to adopt your products', 'following developing market trends' and 'grow business' (see Table 20).

5.3.2 Results of Research Questions

The content analysis in Chapter 4 addressed the two research questions from Chapter One. The research questions were specifically designed to investigate if companies leverage their position in standards groups.

The Chapter 4 study of the quantitative and qualitative analysis provided measurable results that enabled this current research to present specific responses for the key research questions identified:

1) ***What strategies are developed by member companies seeking to position themselves into positions of influence?***

Summary Conclusion: The statistical analysis and interview results appear to agree in suggesting that a variety of committee activity is the strategy most engaged by members who seek influence within the A4WP standards. Either joining one of the seven committees or multiple committees is a strategy used by 50 active members. However, it should be noted that membership in two subcommittees (Certification/Test and Regulation) had statistical significance in only one regression models. The importance of each committee was asked specifically during the interview questions, and the top answers stated the technical committees (Committee 5 - Tech 1, Committee 6 - Tech 2, and Committee 7 - Resonator) were identified in the transactions as key committees for companies seeking to influence the A4WP. The regression analysis, however, shows

that committee involvement is much more complicated. Committee membership, for example, also creates networks, and the network ties between member firms as measured by centrality (both Degree and Betweenness) are important in influencing standards as well as the power achieved by a committee chairmanship position.

Intellectual Property (IP) was mentioned during the interviews multiple times as a key method leveraged to seek influence for active members. The IP variables were also identified in the regression analysis as significant. Key themes around gaining early access to technology specifications as a method of placing and teaching other members their company IP was mentioned by 80% of the respondents (see Table 20).

The cluster analysis of themes from the interviews also provided insights into the strategies used by firms. Two clear strategic emerged (Table 30). Cluster one was identified as a group of 'Technology Prospectors', representing members who joined the A4WP to actively gain access, knowledge, and insights to the technologies being developed in an emerging market. The highest scoring theme with 100% from the frequency chart on Table 20 was 'following all developing market trends', cluster one firms position themselves this way. On the other hand, cluster two represents firms identified more as, 'Technology Sellers'. These members directly place themselves in positions within various working committees and the AW4P BoD's infrastructure where they can positively influence the technical specifications around the IP they own.

2) ***Do large companies have an advantage due to size and available resources over the smaller member companies who may not be able to support contributing equally to the standard setting process?***

Summary Conclusion: This research question was tested in both the baseline regression analysis and the full models. The size variable was positive and statistically significant in the majority of the estimated regression models. The results from the interviews also confirmed that members expressed the opinion that larger companies are able to gain an advantage over smaller member companies in the A4WP.

The results of the interview questions number ten and fourteen indicates that large companies are seen as the most important and influential for making the A4WP successful. The themes identified from the 20 transcripts on several questions support this. The answers to question eight (most talked too), question nine (most important)

and question thirteen (needed to succeed) were all 'Large' companies, these key themes measured between a 65-70% response rate in the frequency chart in Table 20.

5.3.3 Summary of Section 5.3

Sections 5.3.1 and 5.3.2 analysed the current research's original objectives and questions from Chapter 1.

The objectives of this current research were also addressed in Chapter 4 by processing the data gathered. Understanding the motivations, attitudes and the amount of energy members have for the A4WP was a large component of this research. The objective of understanding the motivation of supporting membership was simply stated in the responses from one interview that saw A4WP membership as, "an efficient way, ultimately, to find a large market". Likewise, other interviewees commented that membership is an efficient method and strategy of aiding their product success. Member companies that focused on the creation of standards can position themselves to leverage their own company's product or service. Interview question five asked about perceived risks, "dealing with competitors" was mentioned multiple times. In spite of this concern, the executives interviewed all appeared comfortable with co-operating with competitors. Member companies were all aware of the co-opetition environment, and to some degree modified their interactions to prevent loss of position as noted by one of the interviewees "without tipping your hat too much in terms of what you plan to do or who you're working with". Furthermore, standards activity requires resources in terms of time and people. The commitment to, and time needed, to best work with a standards-based alliance is significant if the company desires greater influence as its outcome.

Having addressed each of the two questions, both the quantitative and qualitative data analysis was able to demonstrate how active members seek to leverage their company into positions of influence. The results provided insights about how member companies leverage their size, their network ties within the standards alliance, and their IP portfolio for their own advantage within the standard setting alliance.

Not only do these results make an important contribution to the scholarly literature on technology standards, but the results can also serve as a potential guide for how a member can gain leverage within standards-based alliances such as the A4WP.

5.4 Contribution – Academic and Professional

Academic: The results of this current research contribute to the large, and growing base of previous academic research in standards organisations, co-opetition and competitor ecosystems by investigating the interactions between members. Co-opetition within the context of a technology standard setting alliance represents a critically important, but understudied slice of this larger body of strategic alliance research. One reason why co-opetition behaviours have not been well examined in formal standards alliance is simply the problem of access to the required data, such as committee meeting minutes and reports, to effectively investigate social network relationships, standard setting influence, and other strategic behaviours.

These exchanges and connections could be considered as part of standards membership, but upon investigation these connections are often used as a key leveraging strategy for some member companies. Bar and Leiponen (2014) concluded that their research contributed to the literature on co-operative standards setting by presenting results that "suggests that managers should pay attention to the strategic information exchange opportunities in co-operative industry organisations... and that policy-makers [active members] may potentially exploit firms' strategic networking behavior" (Bar and Leiponen, 2014, p.20). The current research complements, and essentially confirms, the statistical results of both Bar and Leiponen (2014) and Dokko and Rosenkopf (2010), but also expanded this prior research with additional hypotheses, and direct interviews with alliance members.

In Chapter 2, a number of research gaps in the technology standard setting literature were identified. The present research specifically addressed several of these research gaps. In particular:

Research Gap Addressed – Few empirical studies of the internal workings of standard-setting alliances: Very few empirical studies exist that examine the internal workings of these alliances. The two notable exceptions being Bar and Leiponen (2014) and Dokko and Rosenkopf (2010). The present study adds to this small, but important area of research.

Research Gap Addressed – Interview/qualitative details: There are very few published articles that include direct interview material about the subject matter,

particularly in conjunction with a quantitative analysis. The current research was able to include interviews; and examine the interview results in conjunction with the quantitative analysis. The present study is a rare empirical study of a standard-setting alliance that included both quantitative and qualitative components.

Research Gap Addressed – Wireless Power specific literature: The present study is one of the first empirical studies that examined strategic behaviour in the wireless power industry, and the first that examined standard setting behaviour in this industry. Wireless power is a relevant technology sector to examine, due its future potential and importance.

Research Gap Addressed – The influence and power of members: Although the existing literature on standard-setting through alliances includes discussions of several characteristics, there remains a gap in the literature regarding measuring the value and influence that individual member companies have within an alliance, and how they directly and indirectly influence the decisions of an alliance. The present study specifically examined influence and power. And most importantly, the present study examined a dependent variable that actually measures influence, which is active members who make proposal introductions in developing a new standard setting alliance. Prior studies did not use a direct measure of standard setting influence.

Research Gap Addressed – Replication studies: As previously discussed, while there exist a few in-depth studies of specific standard setting alliances (such as Bar and Leiponen, 2014 and Dokko and Rosenkopf, 2010), there remains a need to replicate and/or specifically build upon these studies in order to confirm and expand the findings and models suggested in these more in-depth studies. The present study represents an attempt to reasonably replicate (given the available data and focus of the present study) prior empirical studies of technology standard setting within a different industry. This replication is achieved with our baseline analysis of three hypotheses.

Professional: From a commercial professional stand point, this research illustrated methods that could be utilized by any company management team seeking to gain a prominent position within a standards-based alliance.

Management Awareness – Committee membership: This research highlights that only active companies are able to propose work items regarding standards definition

and guidelines. Management must decide which committee is best for it to spend its resource and time. Proposing work items and contributing to defining the technical standard is a key strategy of members wishing to influence the development of a standard. As shown in the 2014 data, 94% of all successful work items were proposed by only approximately 10% of the member companies (see Table 9.26). Management must review if they have the resources to support committee membership in order to participate in influencing the standards through committee proposals.

Management Awareness – Contacts with other members: Joining Alliances at every membership entry level allows access to other member companies. Management can determine which competitors they must develop a co-opetition relationship with, also the members they share an interdependency with (customers, suppliers and manufacturers). Targeting and gaining the correct direct contacts is more important than the volume of contacts (see Table 10). In addition, even if a company is not in a position to propose a standard, being active (and central) within the alliance network will allow greater access to those firms that do influence standards. This can provide quicker access to new technology standards and trends.

Management Awareness – Large companies: The quantitative and qualitative results for H3 support that management should be aware of the strength of large member companies. Large companies dominate the BoD by joining early and have positioned themselves in committee chair roles, which again were found to be an accepted method of gaining influence in H6.

Management Awareness – Risk of IP infringement: Over sharing is a key item to avoid within a standards committee meeting. Management must be aware of the risks, receive training if necessary and develop plans to safe guard their IP. During the eigenvector centrality analysis of question four, IP infringement was highlighted as the highest concern (see Table 23).

Management Awareness – Opportunity for IP placement: IP positioning scored highly as a key themed answer of question three B "desired outcome" of membership (see Table 22). Companies with a strong IP portfolio were strongly identified in both the quantitative and qualitative results. Quantitatively both the Euclidean Technology Distance and the USPTO IP were identified as significant factors for the volume of standards proposed (see Table 10). The qualitative analysis found two clusters of active

members, cluster two were 'Technology Sellers' which is mainly large IP focused companies directly positioning and seeking to gain from their IP within the standards-based alliance through licensing agreements (see Table 30).

Management Awareness – Finding customers: 'Technology Prospectors' was the second cluster found in the qualitative analysis; this cluster is focused on learning about other's IP, and then developing their products around the standard specifications. This cluster is dominated by members that make semiconductors designed to fit the specific technical specifications. Prospecting new opportunities is cited as the common strategy for this group and by staying in touch with the design of their own products for the A4WP. 'Creating a market for products' was the highest scoring answer to the question 6, which asks what is the value of membership to your product (see Table 25). Cluster one executive's all stated similar answers including 'learning the spec' and 'advancing time to market'. This 'prospecting' methodology may have advantages for other management teams in deciding on their standards-based alliance strategy.

Management Awareness – Alliance members provide services: This research data identified that 36 members are in the 'Test and Certification' membership category of which 24 were attending members of the 'Test and Certification' committee. These members provide qualification services, as with many technology standards, the A4WP products must be qualified through a test and certification process before being available to the public. Management of the 24 active members within this category are strategically positioned to provide this service as approved certification houses for A4WP products. The results of H7 for the quantitative analysis identified this committee as the most significant (other than the BoD). Management of similarly placed service organisations may opt to follow the same strategy of closeness to standards-based alliances.

Management Awareness – When to join: As previously mentioned, this research has found strong support for joining early, gaining strong positions with committees and applying influence to the standards process (H5 was accepted by the quantitative analysis). However the smaller company that holds a significant IP position could join later and achieve a BoD and chairman position as with the case of WiTricity. Also I saw a large company (Intel) join late and receive BoD status and chair of a new committee. Three late BoD members (Broadcomm, Intel and WiTricity) all managed to

accumulate the same highest level of primary contact and access to members. As cited in the research, there is sometimes a benefit for joining late (Wang et al., 2010). This also may be an indication from the economic theory of clubs, that as 'congestion' starts to appear as the alliance grows larger, that larger companies entering later may find difficulty of achieving the same influence as earlier members as the 'club' starts to enact subtle barriers. However, as the research indicated, these influence barriers to later entry may not apply to smaller firms.

Management Awareness – Standards awareness: The highest scoring key theme identified in the research was 'following the market trends' (see Table 20). Members can decide if non-committee membership is the best strategy for them. Every member (even non-committee members) receives weekly/monthly communications from all the committees. Also they receive advance copies of the specifications, are able to attend the Annual General Meetings (AGM's) and gain access to membership contact details (names, titles, email and telephone). Management could decide to 'listen' only and access information without investing large costs of attending meetings and supporting with personnel.

5.5 Limitations

The strength of this research is the focus on the new vertical market of wireless power and its standardisation and preparation for future market adoption. One limitation may be the 'external validity' or generalisability issue – by itself, the research focuses on a narrowly single technology (wireless power), concentrated on a small, very specialist technical product and market. The wireless power industry is at the early stages of development, and existing published material was incomplete. However, generalisation of research is also obtained by contributing to a broader literature that also examines the same topic in depth with other technologies. This was the purpose of the present study, as the research also was focused on recreating that of the baseline from Bar and Leiponen (2014) and centrality from Dokko and Rosenkopf (2010), and thus contributes to the received literature in technology standard setting alliance behaviour.

Second, while the A4WP permitted access to members, and the membership database, there was a limitation placed on that access. There was also a limitation to the number of interviews the author could arrange. These interviews were restricted to four venues that allowed for only 20 face-to-face interviews. However, as previously discussed 20

interviews for a thematic content analysis is certainly within the norm given other published thematic content studies of interviews. The database was restricted to October 23rd 2014, and after that time there was no possibility of additional access during 2015 when the A4WP was merged. However, these types of limitations will always be present in empirical research that attempts in-depth analysis of data from proprietary sources.

5.6 Proposal of Further Research

This current research explored the important role standards organisations play in defining and providing structure in bringing large scale products and technology to market. The available published papers appeared to study a good cross section of industries and technologies. However, the received literatures is almost always limited to external data sources, and focus on standard acceptance in the marketplace, and not on the critical role that standard setting alliances play. Very few published studies on standard setting alliances had access to proprietary data. Future research will benefit from individual member feedback from within the industry and commercial associations. For purposes of generalisation, more in-depth studies of other standard setting alliances will need to take place in the future. As more in-depth studies on alliance behaviour are published, the generalisability of the total body of empirical studies will increase.

The current research, and much of the previously published material, were unable to provide financial data on wither the implementation of the standards was a commercial success or not. The current research was able to examine technology proposals (of which almost all would have been adopted). However, given the current research were not tied to financial components, further research of a longitudinal nature could provide data into the implementation, development and consumer adoption of a technical standard. This would require, however, very carefully measured success metrics at the technology level of analysis, such as a company's speed of adoption, revenues from a particular technology, time to market, and if the standard is not with a company's portfolio how quickly the firm can adopt or research a new standard. These types of metrics require access to proprietary information, but are important issue to really understanding the nature of technology adoption at the alliance and company level. The standards topic could benefit from future research that analyses the costs, resources and

manpower for developing standards together with the commercial monitory results from the standards set.

5.7 Summary of Section 5

This chapter detailed each of the previous chapter's findings and results from the regression analysis, social network positioning, and the qualitative analysis from the interview material. This information was used to summarize the significance of each hypotheses tested. The research objectives and questions were reviewed using the findings from Chapter 4.

The current research's contribution was presented from both an academic and commercial stand point. Academically, this research added the relatively unusual elements of membership access and industry insider contacts. Commercially, this research contributed to creating tested strategies for gaining leverage.

Limitations and suggestions for further research finalised this section, and it is hoped that this research aids further researchers in their academic pursuit. The author strongly hopes that business engage in the methods identified in order to gain leverage within a standards-based alliance.

This chapter concludes the research study subject and findings.

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List of Appendix

Appendix (A): Author Biography

Graham Robertson is the CEO of Grand Bridges, a global high tech consultancy corporation based in San Francisco, California.

Prior to February 2016 he served as Vice President, Corporate Marketing and Channel Product Marketing, at Integrated Device Technology Inc. in San Jose, California. As the Vice President, Graham Robertson was responsible for managing the IDT brand worldwide, as well as Corporate Positioning, Strategic Marketing, Product Launch Management and Market Research. In addition, he was responsible for creating integrated marketing communications and channel campaigns designed to reach customers and stakeholders worldwide. Robertson joined IDT in March, 2010, bringing with him more than 15 years of global semiconductor marketing experience, with a specific focus on increasing brand awareness.

Robertson transitioned to IDT from International Rectifier (IR) where, most recently, he served as the Vice President of Global Marketing and Corporate Communications. Robertson joined IR in 1998 and, during his tenure; IR achieved the No. 1 brand position in the power semiconductor sector worldwide. Graham worked extensively in Europe, Asia, Japan and America, driving market share and sales growth.

Prior to IR, Robertson held Sales and Marketing Communications positions at the global electronics distributor Future Electronic.

He currently resides in San Francisco, California and Melrose Scotland.

Robertson earned his Master of Business Administration degree (MBA) from Edinburgh's Heriot Watt University, and a Master of Science degree (MSc) in Marketing from the University of Glamorgan (now University of South Wales). He also served as the Vice Chairman of Marketing for The Alliance for Wireless Power (A4WP) (2012-2015).

Appendix (B): A4WP Approval Notice

Below is the official email permission from The Alliance for Wireless Power (A4WP) president Kamil Grajski agreeing to the author interviewing and researching the consortia membership.

Authors Reply: Confirming acceptance of permission (November 5th 2013)

From: Robertson, Graham
Sent: Tuesday, November 05, 2013 3:27 PM
To: 'Grajski, Kamil'
Subject: RE: Doctorate Research

Thanks Kamil,

And yes agreed that I will not send anything to the members in a blast but rather individual requests.

My activity will not begin until Dec/Jan time

Cheers

Gr

A4WP Official Permission (November 4th 2013)

From: Grajski, Kamil [mailto:kgrajski@qti.qualcomm.com]
Sent: Monday, November 04, 2013 6:06 PM
To: Robertson, Graham
Subject: RE: Doctorate Research

Hi Graham,

Thank you for your note. And thank you for the courtesy, though not necessary, of checking-in ahead of outreach to A4WP members. Please go ahead as proposed and let me know how I can support this work.

One small suggestion regarding the step of working with a larger group. It may be best even in that context to communicate one-to-one with companies. There is some

additional administrative work for you, but probably best to keep all interactions one-to-one.

Cheers,

Kamil

Kamil Grajski

A4WP

Dr. Kamil A. Grajski is a Vice President, Engineering at Qualcomm. He has 20+ years experience delivering advanced technologies from laboratory to Market in roles ranging from product and standards development to general management. Technology areas include speech and handwriting recognition, assisted-GPS and location-based services, mobile broadcast and most recently wireless power transfer. Kamil is a UC Berkeley PhD in Biophysics and has been with Qualcomm since its acquisition of SnapTrack in 2000. Kamil presently serves as the Founding President of the Alliance for Wireless Power.

Request Email for Permission (November 4th 2013)

From: Robertson, Graham [mailto:Graham.Robertson@idt.com]
Sent: Monday, November 04, 2013 8:21 PM
To: Grajski, Kamil
Subject: Doctorate Research

Kamil,

I mentioned a few weeks ago that I'm soon doing the research element of my doctorate degree.

The research is focused on technology alliances and the need for standardisation. This new research will be on the emerging standardisation of wireless power and will aim to

understand the motivation and objectives of the member companies supporting standardisation.

I'd like to ask your permission to approach members of the A4WP to confidentially share their own and company thoughts for joining. I would like to speak with some of the members of the A4WP individually in qualitative interviews face-to-face (30mins). Then I would like to email a wider membership group a short optional questionnaire (7 questions).

Confidentially is guaranteed to you and your members. The university has strict rules for me to follow and in the final thesis NO company or individual will be named.

My doctorate is with Edinburgh Business School Heriot Watt University which is my MBA school http://www.ebsglobal.net/programmes/self-study-pathway

This study is personal and not associated to my position in IDT.

Please don't hesitate to let me know your thoughts. Cheers Gr

Appendix (C): Alliance for Wireless Power Membership Fee Structure

Alliance for Wireless Power

Membership Fees

October 9, 2013

MEMBERSHIP FEES

The full calendar year membership fees for the Alliance for Wireless Power are laid out below. First year Sponsor and Full membership fees are pro-rated on a quarterly basis for the calendar year; the date of the acceptance of the membership application by the Board of Directors of the Corporation determines the quarter to pro-rate from. Sponsor and Full membership applicants accepted during the last three months of the calendar year are also required to pay one full year membership fees for the next year.

- ☐ Sponsor Membership .....$50,000 USD
- ☐ Full Membership
  - ☐ >$50M Annual Sales.....$25,000 USD
  - ☐ >$5M Annual Sales.....$12,500 USD
  - ☐ <$5M Annual Sales.....$4,500 USD
- ☐ Adopter Membership .....$2,500 USD
- ☐ Test Lab Membership .....$2,500 USD

Appendix (D): CITI: Human Research Training Completion Report (USA interview ethics)

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI)

HUMAN RESEARCH CURRICULUM COMPLETION REPORT

Printed on 04/21/2014

LEARNER Graham Robertson (ID: 4095049)

INSTITUTION University of North Carolina Wilmington

EXPIRATION DATE 04/02/2016

SOCIAL/BEHAVIORAL RESEARCH COURSE: Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

COURSE/STAGE: Basic Course/1

PASSED ON: 04/03/2014

REFERENCE ID: 12706612

REQUIRED MODULES DATE COMPLETED SCORE

University of North Carolina Wilmington 03/31/14 No Quiz

Belmont Report and CITI Course Introduction 03/31/14 3/3 (100%)

Students in Research 03/31/14 10/10 (100%)

History and Ethical Principles - SBE 03/31/14 5/5 (100%)

Defining Research with Human Subjects - SBE 04/01/14 5/5 (100%)

The Regulations - SBE 04/01/14 5/5 (100%)

Assessing Risk - SBE 04/01/14 5/5 (100%)

Informed Consent - SBE 04/02/14 5/5 (100%)

Privacy and Confidentiality - SBE 04/02/14 4/5 (80%)

Research with Prisoners - SBE 04/02/14 4/4 (100%)

Research with Children - SBE 04/03/14 4/4 (100%)

Research in Public Elementary and Secondary Schools - SBE 04/03/14 4/4 (100%)

International Research - SBE 04/03/14 3/3 (100%)

Internet Research - SBE 04/03/14 5/5 (100%)

Conflicts of Interest in Research Involving Human Subjects 04/03/14 2/5 (40%)

Paul Braunschweiger Ph.D.

Professor, University of Miami

Director Office of Research Education

CITI Program Course Coordinator

Appendix (E): Questionnaire Template

A4WP member's questionnaire: The format of a typical five-level Likert scale:

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

1) You see strong advantages of alliance membership

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

2) You see strong risks of dealing with competitors

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

3) You see strong innovation advantages from alliance membership

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

4) You could bring your product to market without membership

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

5) You see the value for the need of a technology certification for WP consumer products

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

6) Your company has safe guards for interaction with competitors

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

7) You will recommend continued membership

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

8) Do certain large companies get more say in the A4WP standards

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

9) Do member companies operate politically to gain favour/positions of power?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

10) Are there informal strategic alliances formed between member companies within the A4WP to influence the outcome of policy?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Comments:

Additional Comments about standardisation:
• Top three member companies you interact with most a).....b).....c)..... • Why? • Which committee are you a member of? • In your opinion what is the most important committee?

Appendix (F): Wireless Power Technology – Magnetic Induction Standards

Magnetic induction supporters have formed two major alliances:

Wireless Power Consortium (WPC) www.wirelesspowerconsortium.com

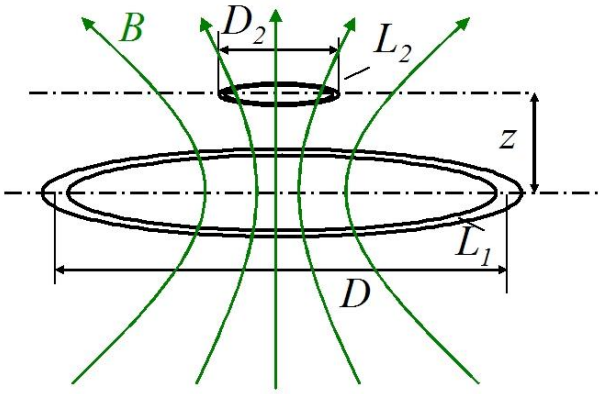
Power Matters Alliance (PMA) www.powermatters.org

The WPC (Wireless Power Consortium) was formed in 2008 and boasts over 200 member companies. Their mission is to establish the global standard for wirelessly charging electronic products, and products are available in the United States, Asia Pacific, and Europe.

Key members and Board members include some large-scale organisations covering automotive, smartphones, semiconductors and wireless network carriers such as, Continental Automotive, Delphi Automotive, Freescale Semiconductor, Integrated Device Technology (IDT), LG Electronics, Nokia, Panasonic, Qualcomm Inc., Sony Corp., Texas Instruments, Toshiba and Verizon Wireless, among others.

The PMA (Power Matters Alliance) was formed later in 2012, and consists of over 100 member companies (fifty percent less than the WPC). Their mission is to deliver certification that achieves global interoperability, develops technical specifications based on open standards, meet energy efficiency and regulatory requirements, and promote the brand. Their board includes representatives from AT&T, Starbucks, Proctor and Gamble (Duracell), Energy Star and Flextronics. They too are focused on building out a worldwide ecosystem to support standards adoption.

The diagram below, taken from Waffenschmidt (2011), presents the basic principle of an inductively coupled power transfer system that both the WPC and PMA promote.



This system consists of a transmitter coil L1 and a receiver coil L2: "A typical arrangement consisting of a transmitter coil and a receiver coil. An AC current in the transmitter coil generates an alternating magnetic field, which induces a voltage in the receiver coil used to power a load" (Waffenschmidt, 2011, p. 1).

A wireless power unit can be restricted and limited by the barrier of power losses. Wasted electricity burns off as heat, which is highly undesirable in consumer goods that need to be energy efficient. (Waffenschmidt, 2011) represented the power loss factor in the equation below describing the sum of all losses related to the transferred power:

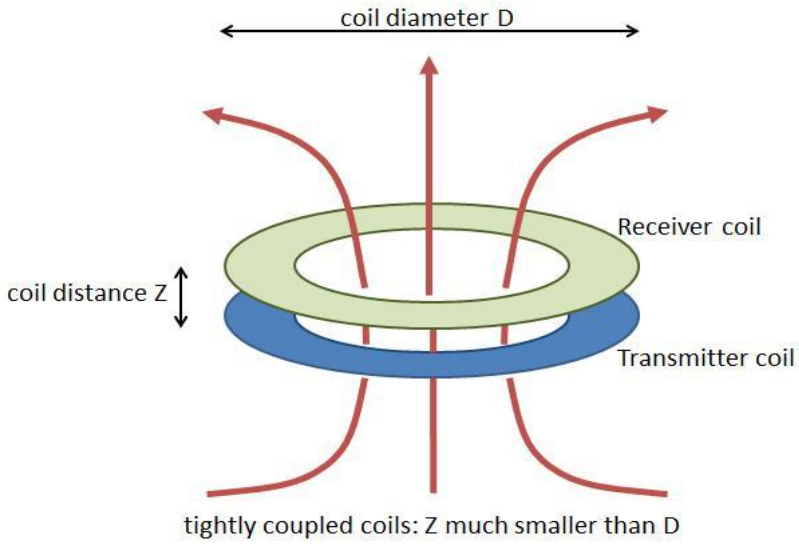
$$\lambda = \frac{P_{loss}}{P_{out}}$$

A deeper analysis results in a minimum loss factor, which can be achieved by a given wireless power system, if generator and load are proper matched:

$$\lambda_{\min} = \frac{1}{(k.Q)^2}.\left(2+\sqrt{(k.Q)^2+1}+\frac{1}{\sqrt{(k.Q)^2+1}}\right)+\frac{1}{\sqrt{(k.Q)^2+1}}$$

Magnetic induction transmitter and receiver coils are tightly coupled when (a) the coils have the same size, and (b) the distance between the coils is much less than the diameter of the coils. Tightly coupled coils operate in smaller areas.

Image from: www.wirelesspowerconsortium.com



Appendix (G): Wireless Power Technology – Magnetic Resonance Standards

Magnetic Resonance has rallied around one major standard-based organisation focused on the 6.78MHZ frequency, which is The Alliance for Wireless Power (A4WP).

rezence
Alliance for Wireless Power

www.rezence.com

The A4WP was formed in 2012 and has 137 member companies (October 2014). Their mission is to establish their 'Rezence' brand as the single standard for all magnetic resonance wireless charging globally for all ranges of power needs (<1Watt to >50Watt). They secured this single magnetic resonance default standard as a result of industry consolidation. This relatively unique position following the 2013 decision from Intel Inc. to drop their own magnetic resonance standard and Wi-Tricity's decision to not develop their own magnetic resonance standard, leaving both to facilitate A4WP adoption: "Both Intel and Wi-Tricity are board members of the A4WP, helping to drive the technical direction and adoption of the Rezence specification" (www.powerpulse.net 2014). The next major consolidation happened early 2014, when the PMA (power Matters Alliance) announced that it would not develop a magnetic resonance technology, but rather will encourage its members to use the A4WP standard: "This

agreement demonstrates the commitment between the two organisations to drive momentum toward an interoperable global wireless power standard" (The Wall Street Journal, February 11th, 2014, p.1).

The A4WP board members consist of Qualcomm, Samsung, Gill Industries Broadcom, Integrated Device Technologies (IDT) and new board members Intel Inc. and Wi-Tricity.

Key members and board members include some large scales organisations covering automotive, smartphones, semiconductors and wireless network carriers such as, Continental Automotive, Delphi Automotive, Freescale Semiconductor, Integrated Device Technology (IDT), LG Electronics, Nokia, Panasonic, Qualcomm Inc., Sony Corp., Texas Instruments, Toshiba and Verizon Wireless etc.

Magnetic resonance allow the coils to be loosely coupled, and this allows the energy to travel and operate at a larger distance, and can travel through materials, for example, through counter tops.

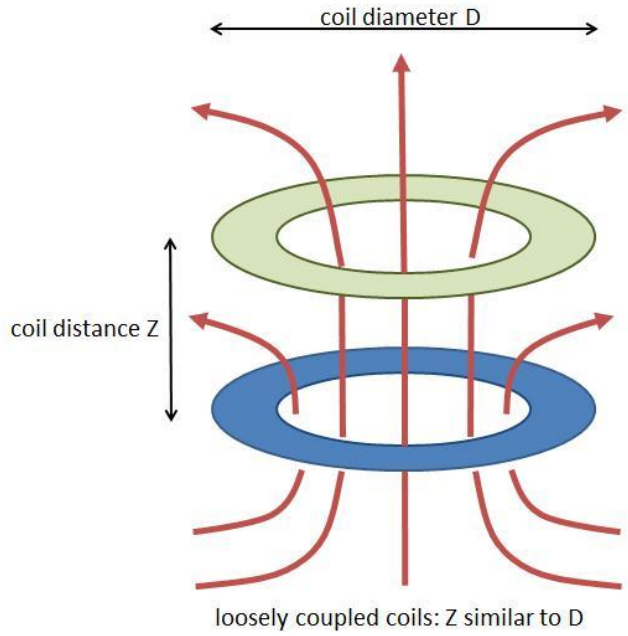


Image from: www.wirelesspowerconsortium.com

This research will focus on one of the standards bodies (A4WP) and explore the individual member company motives and intention from membership and development of the magnetic resonance standards.

www.rezence.com cites...

SOLUTION: Meet Rezence, The Next Generation in Wireless Charging Technology

Rezence is based on the concept of spatial freedom, which extends wireless power applications “beyond the mat” and accessories market into almost any mobile device or surface.

SUPERIOR CHARGING RANGE

A superior charging range allowing for a true drop and go charging experience, through almost any surface and through objects such as books and clothing.

MULTI-DEVICE CHARGING

Ability to charge multiple devices with different power requirements at the same time, such as smartphones, tablets, laptops and Bluetooth headsets.

READY FOR THE REAL WORLD

Charging surfaces powered by Rezence will operate in the presence of metallic objects such as keys, coins, and utensils, making it an ideal choice for automotive, retail, and kitchen applications.

BLUETOOTH COMMUNICATION

Uses existing Bluetooth Smart technology, minimizing the manufacturer's hardware requirements, as well as opening the door for future, Smart Charging Zones.

Appendix (H): Member Names of Each Cluster

Member Company Interviewee	Cluster Number
Interview Five	1.00
Pilot One	1.00
Interview Three	2.00
Pilot Six	1.00
Interview One	2.00
Interview Four	2.00
Pilot Three	2.00
Interview Two	2.00
Interview Nine	2.00
Interview Eight	2.00
Interview Thirteen	1.00
Pilot Two	1.00
Interview Seven	2.00
Pilot Four	2.00
Pilot Five	1.00
Interview Fourteen	2.00
Interview Eleven	1.00
Interview Ten	1.00
Interview Twelve	1.00
Interview Six	2.00

Cluster One n=9 and Cluster Two n=11

Appendix (I): Ward Method, Question 1, 4, 5 and 6

Group Statistics

Ward Method	N	Mean	Std. Deviation	Std. Error Mean	t-stat	Significance
1	9	1.78	.441	.147		NS
2	11	1.82	.603	.182		

1	9	.44	.726	.242		NS
2	11	.36	.809	.244		
1	9	1.22	.972	.324	2.330	0.032
2	11	.36	.674	.203		
1	9	1.44	.726	.242	2.824	0.011
2	11	.45	.820	.247		
1	9	1.78	.441	.147	3.785	0.001
2	11	.64	.809	.244		
1	9	2.00	.000	.000		NS
2	11	1.91	.302	.091		
1	9	.11	.333	.111		NS
2	11	.09	.302	.091		
1	9	.67	.866	.289		NS
2	11	.73	.647	.195		
1	9	1.00	1.000	.333		NS
2	11	.82	.982	.296		
1	9	.67	1.000	.333		NS
2	11	.64	.924	.279		
1	9	1.33	.866	.289	2.325	0.032
2	11	.45	.820	.247		
1	9	1.89	.333	.111		NS
2	11	1.64	.674	.203		
1	9	1.67	.707	.236	2.396	0.028
2	11	.91	.701	.211		
1	9	1.67	.707	.236		NS
2	11	1.18	.982	.296		
1	9	1.89	.333	.111		NS
2	11	1.73	.647	.195		
1	9	1.89	.333	.111	4.906	0.001

2	11	.45	.820	.247		
	9	2.00	.000	.000	2.488	0.023
1						
2	11	1.18	.982	.296		
	9	.11	.333	.111	-1.748	0.097
1						
2	11	.73	1.009	.304		
	9	.11	.333	.111	-3.489	0.001
1						
2	11	1.36	.924	.279		
	9	.33	.500	.167		NS
1						
2	11	.64	.924	.279		
	9	.22	.441	.147		NS
1						
2	11	.64	.809	.244		

Appendix (J): Social Network

The Importance of Social Network Analysis to this Research

Social Network Analysis (SNA) tools enable an empirical examination into interactions within a group or multiple groups or individuals. Similar to the baseline work of Bar and Leiponen (2014) this current research sought to identify the number of interactions each member company of the A4WP has with the other members during the activities of seven working committees over a three year period. The 137 members gain connections between each other in multiple situations during their activities in providing the technical specifications, market analysis, etc. for the working committees. SNA software tools call these member companies ‘nodes’ and two ‘nodes’ are connected/linked in this case if they are active in the same committee, SNA maps and

measures the links between 'nodes' and provides both visual and mathematical analysis of these connections. Analysis of these connections can identify individual member companies that are actively seeking primary contacts as a result of their support of the A4WP.

Social Network Analysis: History and Background

Borgatti et al. (2009) trace the ideas of Social Network Analysis first dating back to works by Comte in the early 19th century. This early literature was largely used to explain small groups that have a common action, and was refined 50 years later by others, for example: "Durkheim had argued that human societies were like biological systems in that they were made up of interrelated components" (Borgatti et al.,2009,p. 892).

Moreno (1934) took a more calculated and measured method as his approach in developing "a technique for a process of classification which is calculated, among other things, to bring individuals together who are capable of harmonious inter-personal relationships and so creating a social group which can function at the maximum efficiency" (Moreno,1934, p.16). Through the increased awareness of SNA and the increased interest of the established academic institutions in social effects, researchers began focusing on the advancement of scientific measurements; as one anthropologist put it: "I have defined social anthropology as the study of human society" (Radcliffe-Brown, 1940, p.2).

In the mid-20th century Alex Bavelas (1948) applied mathematical formulas to social networks and began to analyses "theories which explain human behaviour as a function of factors which may be coexistent but independent of each other, and theories which explain human behaviour as a function of groups of factors constituting a continuously interacting field" (Bavelas, 1948, p.16). This research gave SNA an extra level of creditability as a social science, with measurements and models that could transfer into other disciplines: "The work done by Bavelas and his colleagues at MIT captured the imagination of researchers in a number of fields, including psychology, political science, and economics" (Borgatti et al., 2009 p. 892). The image below shows four network structures examined by Bavelas and colleagues at MIT. Each node represents a person; each line represents a potential channel for interpersonal communication. The most central node in each network appears in red. (Borgatti et al., 2009, p. 893).

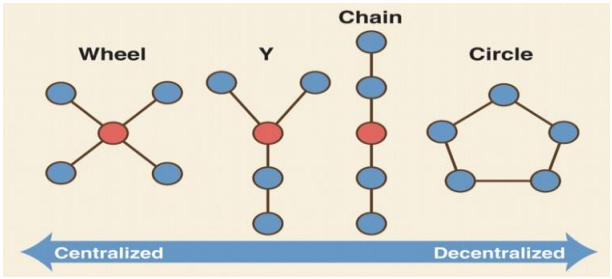


Figure 31: Borgatti et al. Network Structures

SNA Software and Relationship Diagrams

UCINET, developed at the University of California, Irvine, is popular in social sciences to analyse sociometric survey data, and has a number of features that identify clusters of groups, multivariate statistical groups and blockmodelling. The variables UCINET measures in the present study are from the input of data drawn from A4WP. The study details the interactions of the 137 A4WP members in seven working committees by using meeting minutes showing member attendance and activity over a three year period. The Bar and Leiponen (2014) research followed a similar structure of analysing attendance and contributions from 44 company members in 64 working committees over a four-year period. Bar and Leiponen (2014) divided the members into active and non-active companies or 'supporters' and 'sources'. The A4WP data shows the number of 'supporters' (active) is 50 and 'sources' (non-active) is 87 companies (as of October 2014) and will follow the same type of analysis. The UCINET software produces diagrams which display each connected members connection in relation to each of the seven committees.

SNA Centrality Illustrations Dokko and Rosenkopf (2010).

Measuring the A4WP members using the SNA tool assists in locating the centrality of a node (member). Centrality is usually considered a position of power within a social network. This measurement illustrates the various roles and groups within the membership of the A4WP. SNA can show if members are acting in one of four different strategic types of 'nodes' 1) Connectors 2) Mavens (trusted expert) 3) Bridges and 4) Isolates. It also illustrates where the clusters are, and which members are at the core and which members are in the periphery. Dokko and Rosenkopf (2010) studied wireless standards organisations similar to the baseline study of Bar and Leiponen (2014) and they investigated how influence (centrality) was achieved by the member

firms “To calculate degree centrality, we computed each firm's centrality based on its participation in subcommittee meetings. Using the meeting rosters, we create a firm-by-meeting affiliation” (Dokko and Rosenkopf, 2010, p.684). Bar and Leiponen (2014) identified in their research positions of influence as the amount of primary, secondary and tertiary contacts gained by each member.

Social network studies have identified and categorized centrality measurements “The general notion of centrality encompasses a number of different aspects of the 'importance' or 'visibility' of actors within a network” (Faust, 1997, p. 160). Networks typically show four popular kinds of centrality, 1) **Closeness Centrality:** measures and identifies nodes that have a superior position within a group and is aware of all that is taking place and three additional centrality measures that examine the issue of gaining positions of power 2) **Eigenvector Centrality:** which is a measure of the power and influences a node, has in the network. 3) **Degree Centrality:** measures the amount/quantity of connections each node has 4) **Betweenness Centrality:** measures when a node is a significant connection between two other nodes. Dokko and Rosenkopf (2010) explored Betweenness and Degree centrality measures based on previous studies from Freeman (1977). Freeman Betweenness Centrality is defined by Freeman as the centrality measure of the amount of interactions between each node or company and Freeman Degree centrality is the measurement of the number of connections each node or member has.